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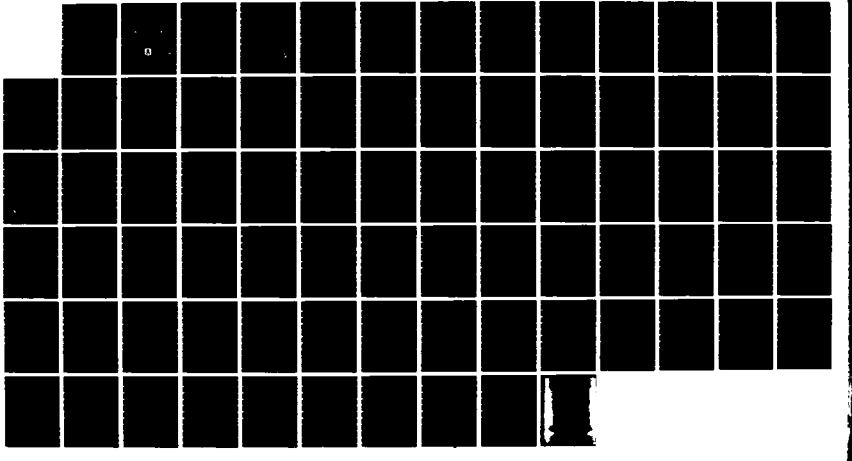

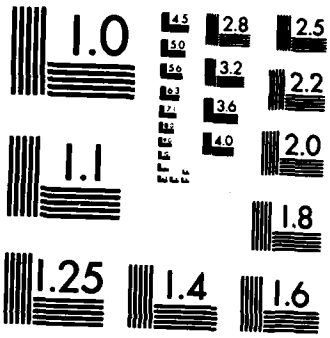

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December 1983

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ROME AIR DEVELOPMENT CENTER

AIR FORCE

TECHNICAL OBJECTIVE DOCUMENT

FY - 85

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AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

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This TOD describes the technical programs of the Rome Air Development Center in support of the Air Force Command, Control, Communications, and Intelligence (C^3I) mission. The technical objectives have been aligned with the VANGUARD mission areas of Command, Control, and Communications (C^3), Reconnaissance and Intelligence, Strategic Systems (Defense), and Technology as a means of focusing the RADC support of VANGUARD. This document is prepared to provide industry and universities with the midterm technical objectives in these areas.

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Reliability
Compatibility

Block 17 (Continued)

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17
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This report has been reviewed by the RADC Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be releasable to the general public, including foreign nations.

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APPROVED:

FOR THE COMMANDER:

CARLO P. CROCETTI
Chief, Plans Office

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INTRODUCTION

The Air Force Technical Objective Document (TOD) program is an integral part of the process by which the Air Force plans and formulates a detailed technology program to support the development and acquisition of Air Force weapon systems. Each Air Force laboratory annually prepares a Research and Technology (R&T) Plan in response to available guidance based on USAF requirements, the identification of scientific and technological opportunities, and the needs of present and projected systems. These plans include proposed efforts to achieve desired capabilities, to resolve known technical problems, and to capitalize on new technical opportunities. The proposed efforts undergo a lengthy program formulation and review process. Generally, the criteria applied during the formulation and review are responsiveness to stated objectives and known requirements, scientific content and merit, program balance, developmental and life cycle costs, and consideration of payoff versus risk.

It is fully recognized that the development and accomplishment of the Air Force technical program is a product of the teamwork on the part of the Air Force laboratories and the industrial and academic research and development community. The TOD program is designed to provide to industry and the academic community, necessary information on the Air Force laboratories' planned technology programs. Each laboratory's TOD is extracted from its R&T Plan.

Specific objectives are:

a. To provide planning information for independent research and development programs.

b. To improve the quality of the unsolicited proposals and R&D procurements.

c. To encourage face-to-face discussions between non-Government scientists and engineers and their Air Force counterparts.

One or more TODs have been prepared by each Air Force laboratory that has responsibility for a portion of the Air Force Technical Programs. Classified TODs are available from the Defense Technical Information Center (DTIC) and unclassified/unlimited TODs are available from the National Technical Information Service (NTIS).

As you read through the pages that follow, you may see a field of endeavor where your organization can contribute to the achievement of a specific technical goal. If such is the case, you are invited to discuss

the objective further with the scientist or engineer identified with that objective. Further, you may have completely new ideas not considered in this document which, if brought to the attention of the proper organization, can make a significant contribution to our military technology. We will always maintain an open mind in evaluating any new concepts which, when successfully pursued, would improve our future operational capability.

On behalf of the United States Air Force, you are invited to study the objectives listed in this document and to discuss them with the responsible Air Force personnel. Your ideas and proposals, whether in response to the TODs or not, are most welcome.

HOW TO USE THIS DOCUMENT

Unsolicited proposals to conduct programs leading to the attainment of any of the objectives presented in this document may be submitted directly to an Air Force laboratory. However, before submitting a formal proposal, we encourage you to discuss your approach with the laboratory point of contact. After your discussion or correspondence with the laboratory personnel, you will be better prepared to write your proposal.

As stated in the "AFSC Guide for Unsolicited Proposals" (copies of this informative guide on unsolicited proposals are available by writing to Air Force Systems Command/PMPR, Andrews Air Force Base, Washington, DC 20334), elaborate brochures or presentations are definitely not desired. The "ABCs" of successful proposals are accuracy, brevity, and clarity. It is extremely important that your letter be prepared to encourage its reading, to facilitate its understanding, and to impart an appreciation of the ideas you desire to convey. Specifically, your letter should include the following:

1. Name and address of your organization.

2. Type of Organization (Profit, Nonprofit)

3. Concise title and abstract of the proposed research and the statement indicating that the submission is an unsolicited proposal.

4. An outline and discussion of the purpose of the research, the method of attack upon the problem, and the nature of the expected results.

5. Name and research experience of the principal investigator.

6. A suggestion as to the proposed starting and completion dates.

7. An outline of the proposed budget, including information on equipment, facility, and personnel requirements.

8. Names of any other Federal agencies receiving the proposal (this is extremely important).

9. Brief description of your facilities, particularly those which would be used in your proposed research effort.

10. Brief outline of your previous work and experience in the field.

11. If available, you should include a description brochure and a financial statement.

CENTER MISSION

RADC plans and executes research, exploratory, and advanced development and selected acquisition programs in support of Air Force Command, Control, Communications and Intelligence (C3I). Technical support is provided to technology intensive C3I programs at the AFSC Product Divisions and other Air Force and DOD agencies. The principal technical areas are communications, intelligence and reconnaissance, surveillance, command and control, electromagnetic sciences, solid state sciences, and electronic reliability, maintainability, and compatibility.

RADC is the AF laboratory responsible for the development of a strong technology base in support of AF C3I. RADC has facilities and resources to accomplish its mission at Griffiss AFB, New York and at Hanscom AFB, Massachusetts. An establishment directly subordinate to the Electronic Systems Division (ESD), RADC reports directly through its Commander, RADC/CC to the Commander, ESD/CC for mission accomplishment.

The major responsibilities are to plan and manage comprehensive research, exploratory development, and advanced development programs in C3I technical areas consistent with the overall C3I technology needs of the AF and to promote the transition and application of technology in conjunction with AFSC system acquisition divisions and other using commands/agencies.

The former responsibility is accomplished through the establishment and maintenance of competent and comprehensive in-house capabilities and through contractual support. The latter is accomplished by providing technical expertise, consultation services and management support to AFSC system acquisition divisions, primarily ESD, test centers and ranges and other AF and DOD agencies as appropriate in regard to studies, analyses, development planning activities, acquisition, test, evaluation, modification, and operation of C3I systems and related equipment.

INVESTMENT STRATEGY

The Laboratory is engaged in the solutions of critical technological problems in support of the Air Force's Command, Control, Communications and Intelligence (C3I) mission.

Future warfare is postulated to be characterized by large numbers of rapidly moving forces and weapons. They will be supported by highly trained personnel and sophisticated electromagnetic combat equipment capable of causing considerable degradation to the AF C3 structure as it is presently equipped and configured. It is the challenge of providing the technology that will insure an effective C3 structure that the Laboratory is addressing. The survivability, capacity, availability, reliability and flexibility are characteristics that are paramount to the success of future C3I systems.

The major direction of our investment strategy follows the VANGUARD mission areas in an attempt to better articulate the purpose and payoff of each program. There are three operationally oriented Technology Planning Objectives (TPOs); namely, C3, Recce/Intel and Strategic Systems. The fourth TPO is Technology and the fifth is Special Projects which contains those efforts that do not logically fall in the C3I mission of the Center, but are accomplished for a variety of reasons.

Within the C3 mission, there are three highly significant deficiencies that formulate the basis of the technology efforts. They are the survivability of C3 systems (both physical and electronic), capacity, and flexibility (the ability to adjust or move into a posture that best meets the situation).

C3 systems are made up of sensors, decision points and control nodes all tied together with communications.

In the Support and Strategic thrusts of the C3 TPO, communications is the primary issue. The technology issues are how to make the communications links and systems capable of providing adequate capacity while being subjected to electronic harassment or loss of nodes. The full use of the spectrum from ELF to EHF, new antenna concepts and adaptive processing techniques are being explored to derive solutions. This is a never ending process since the adversary that would disrupt our communications is also devising new methods of doing it.

In the tactical portion of this TPO, the concerns cover all of the functions of the tactical C3 systems from the sensor through force management to the issuance of control instructions. The largest portion of the Center's 6.3 resources go into this area. Sensors are notorious for their lack of coverage and capabilities when under electronic and physical attack. The current program addresses both of these issues by providing far greater ECCM and physical security through improved antennas, signal processors, netting and mobility.

Success of the programs will make it much more difficult for even the most sophisticated enemy to eliminate the sensor system. Additional protection and coverage (capacity) will be gained in the development and insertion of the Advanced Airborne Surveillance Radar. Force management is not new but requires new approaches to improve the process and make it sufficiently timely to keep pace with fast moving situations. The proliferation of data that is available for use in the decision making process dictates that decision aids, data bases, storage and retrieval processes and display techniques be improved through automation. An increasing amount of 6.2 and 6.3 resources are being devoted to this area in a program that is very user dependent and of an evolutionary nature. The distribution of data bases and functions throughout the TACS will provide much of the required system survivability and flexibility though it implies increased loading of the communications within the system.

The use of fiber optics, millimeter waves, adaptive LOS/Tropo/HF and satellite techniques are all being pursued to provide the variety and flexibility needed to have a secure, survivable and flexible communications system that can respond to many varied situations. There are specific efforts looking at the intra center and at the inter center problems since they are significantly different.

Control is yet another challenge in survivability, flexibility and cost reduction. Low cost family type data links and improved air/ground/air and air/air communications is a critical need. The use of low probability of intercept techniques along with adaptive antenna concepts should result in the solutions required for this function.

The importance of intelligence in the strategic and tactical environments has always been recognized. The problem is that the sensor development, data sources and complexity of the information/weapons has out stripped the capability of the system to exploit and handle the volume.

The Center's program is directed at solutions to these exploitation, handling, and usage issues. Within this program are solutions to the problems of strategic/national intelligence, real time tactical and the Air Force's mapping and charting requirements. Although requirements differ, similar techniques in change detection, data base manipulation, hard and soft copy data exploitation and display are needed.

All of this is highly dependent on the use of automation and specific software solutions. The output of this program, which is heavily customer funded, will be the capability to accurately, and, within the required time, present the intelligence data at the desired level of consolidation.

Strategic sensors to perform surveillance of the aerospace environment are critical to the conduct of the strategic warning mission. In the past, RADC has developed and fielded many such electromagnetic and optical sensors. All of these ground based units have deficiencies in coverage, survivability and life cycle costs.

The current RADC program, which is heavily DARPA funded, is directed at the development of the technologies to permit the surveillance mission to be performed from space. Both radar and optical approaches are being pursued.

Emphasis is continuing in space optics and structures technology for advanced warning systems where major advances in adaptive ultra light-weight mirrors, advanced passive light-weight mirrors, sensors and actuators should lead to advanced active and passive telescope optics. However, serious deficiencies needing attention is the integration and control of these components, as well as rapid optical fabrication technology.

Technology is by far the largest consumer of the Center's manpower. This is an appropriate investment in that within this TPO are all of the important 6.1, 6.2 and some 6.3 programs that provide the critical technologies for future improvements in the systems oriented TPOs. Further, this technology work is very manpower intensive. The payoff of this work is not clearly shown in the form of current mission improvements but rather in the potential capabilities of future systems. Some of this work is very high risk, but is believed to be an acceptable investment.

The areas of technologies are Surveillance, Communications, Electromagnetics, Solid State Devices, Recce/Intel, Reliability, Maintainability and Compatability, and Information Processing.

Surveillance, communications and recce/intel have very close ties to the above mission oriented TPOs, and represent futuristic extensions of the fundamental needs of them.

Electromagnetics is devoted to the basic problems involved in antennas, RF components, electromagnetics of targets and the environment, and propagation.

Solid State Devices deal with the issues involved in system timing, advanced signal processing and electro-optical devices, electromagnetic materials, and electromagnetic radiation hardening. There is significant 6.1 investment in the latter two subthrusts.

Reliability, Maintainability and Compatability is the thrust that seeks solutions to the ever present problems of availability of C3 systems. It has been demonstrated that the investment in reliability and maintainability during the development stage of equipment reaps large dividends throughout their lifetime. This technology must keep pace with the advancements in solid state devices and equipment as well as provide fixes for those that persist in failing. The ever decreasing size and weight of C3 hardware permits a corresponding increase in the packing factor. This advantage often is negated because of the mutual interference that often occurs. A program is ongoing to permit the understanding, prediction, and prevention of this condition.

Vital to many of the above programs and desired capabilities is the production, maintenance, and operation of software. The Information Processing thrust encompasses these efforts. The obvious payoff of this work is in the reduction of the cost of software, which is rapidly becoming the most expensive aspect of automation. There are major 6.2 and 6.3 commitments in this area which are considered well worth the investment. This thrust also encompasses the emerging area of decision aids/artificial intelligence needed for functionally flexible, responsive and user adaptable aids for improved performance of the decision maker in the C3I environment.

The last thrust is made up primarily of test and evaluation efforts that are important, but do not fit into the other thrusts or into C3I in a strict sense. In most cases, our investment in manpower is small and the funding comes from customers. The major efforts are in HAVE NOTE, to determine the vulnerabilities of weapons avionics to hostile electromagnetic energy; C3 Protective Systems, to measure the effectiveness of aircraft jammers without the large expense of actual flight testing; and the Physical Security Systems (PSS) technology program, a small effort in direct support of the PSS SPO at ESD.

Within these broad objectives, the following major thrusts are addressing high priority Air Force problems:

Advanced Tactical Radar has the payoff/impact of providing the AF with a highly mobile, flexible, jam resistant tactical radar that is fully compatible with modern air target dynamics and has improved survivability from physical attack. This capability will be provided through the design, development and acceptance testing of a tactical ADM radar at C band. Perceived major technological deficiencies are obtaining agile beam, low sidelobe, wideband antennas capable of unambiguous target tracking and automated ECCM waveform management.

Advanced Airborne Surveillance Radar has the payoff/impact of providing the AF with a flexible, jam resistant airborne radar for enhanced (low cross section and/or low doppler target detection) surveillance capability for the 1990's resulting in major advances in AWACS support of tactical and strategic missions. This capability will be provided through demonstrating low sidelobe, electronically scanned arrays which conform to aircraft shape and radiate high power, and through the development of processing algorithms and discriminates. Perceived major technological deficiencies are the development of active and passive conformal arrays as well as shortfalls in autonomous/hybrid baseline development.

Cruise Missile Surveillance has the payoff/impact of providing the AF with high confidence warning, discrimination and tracking capability against the low altitude, low observable penetration threat. This capability will be provided through netted systems using RF transmit signals of opportunity such as broadcast networks (Passive Coherent Location System) and FAA radars, multi spectral automatic track file

generation and reporting, and optimized networks minimizing resources for warning and engagement operations. Perceived major technological deficiencies are low observable penetrator detection and tracking using radiation of opportunity, integration of communication/surveillance networks, and unattended processors for detection, discrimination and tracking.

Fiber Optics for C3I has the payoff/impact of providing the AF with long repeaterless remoted and secure communications with reduced EMP/EMI vulnerability at reduced cost compared to conventional copper cable used within TACS (407L). The improved capability will be provided through the development of advanced fiber optic technology as well as associated optical components and should result in a 10:1 weight reduction and a 20:1 increase in distance over copper cabling. Perceived major technolgical deficiencies are III-V material & device processing, wide bandwidth optical modulation and multiplexing, and low loss fiber optic connectors for tactical use.

Enduring Communications has the payoff/impact of providing the AF with secure, reliable long range communications for C3I. This improved capability will be provided through low probability of intercept and anti-jam features. Perceived major technological deficiencies are frequency management and the selection of the best modulation techniques.

Satellite Communications has the payoff/impact of providing the AF with an airborne satellite terminal capable of high capacity, jam resistant, and low cost communications that is reliable and has low aerodynamic drag antennas. This capability will be provided by addressing terminal segment technology, an EHF adaptive array processor, conformal and hemispheric coverage antennas, and long life TWTS. Perceived major technological deficiencies include exploiting EHF and VLSI/VHSIC technology for the terminal segment, low power and high performance MMIC and MIC for the array processor, reduced cost and high performance for EHF conformal arrays, and ultralong life and high pulsed and CW power tubes.

Multi-Imagery Exploitation has the payoff/impact of providing the AF with a near real time image exploitation capability primarily for tactical targets. This capability will be provided through the utilization of the data handling recording system and through the incorporation of improvements in the baseline system. Perceived major technological deficiencies exist in automatic targeting, identification, target location, and multi-sensor handling.

Cartographic Applications for Tactical and Strategic Systems (CATSS) has the payoff/impact of consolidating AF digital cartographic data requirements and of providing the capability to manipulate/exploit data bases. This capability will be provided by standardizing cartographic data base requirements and by the optimal use of limited data production facilities. Perceived major deficiencies are overlapping/conflicting cartographic data requirements, limited cartographic data production facilities, and unexploited sources of additional intelligence

information.

Decision Aids has the payoff/impact of providing the AF with an interactive decision aids capability to assist the tactical decision maker in utilizing data in a logically consistent manner in tasks that involve evaluation, assessment, inference and prediction. This capability will be provided by development and evaluation of flexible decision aids using existing technology and the design of advanced aids for uniquely military decision situations beyond current capabilities. Perceived technical deficiencies are the technical issues associated with knowledge acquisition, functional utility, and flexible interaction.

Space Based Radar has the payoff/impact of providing the AF with a global all-weather capability of surveillance of bomber/cruise missile carriers independent of geo-political considerations. This capability will be provided through large aperture phased array analysis/simulation, phase-shift lens development and test, advances in feed technology, and advances in onboard signal processing. Perceived major technological deficiencies are lightweight space-fed lens, on-board signal processing, and monolithic lightweight/low cost transmit-receive modules.

The strategy for the investment of resources addressing these objectives and thrusts is based upon the identification of the most pressing C3I problems and projected military threats as well as upon the awareness of the broad spectrum of Air Force C3I requirements. Guidance for optimum resource investment is obtained from documents such as AFSC's Project VANGUARD mission areas and development goals, Technology Needs (TNs), the AFSC Research Planning Guide, Tactical Air Force Integrated Information System (TAFIIS), Operational Command GOR's/SON's, DIA's all source intelligence information, and technological opportunity.

The objectives are addressed through the application of available 6.1, 6.2, and 6.3 resources arriving at the optimum program mix through the process of planned program management.

COMMANDER'S ASSESSMENT

The condition of the laboratory remains, in general, very good. Over the past year, there have been some important milestones toward the Air Force's capability to perform its Command, Control, Communications, and Intelligence (C3I) mission (PAVE MOVER Radar flight tests, SPEAKEASY Voice Terminals, TRC 170 ECCM Kit). The level of manning is acceptable but critical funding is losing to inflation.

There are some problems, primarily in the availability of 6.3 funding needed to improve the technology demonstrations which lead to effective technology transfer. Without these 6.3 resources, there may be a number of missed opportunities during the coming years (Advanced Airborne Surveillance Radar, Multiple Use Frequency Standards, Intelligence Processing Techniques, etc.)

Total Center authorized manning will increase by 3 as of 1 Oct 83 due to an increase in the civilian manning for the Fiber Optics Program. Through an active recruitment program, we have been able to maintain a relatively constant level of S&E personnel. Retirements cost in the sense that there is a loss of experience and corporate memory, but the new engineers bring with them great enthusiasm and fresh ideas. The real management challenge is to retain these bright young men and women.

Total funding for the Center has increased by 12% from FY 82 to FY 83 but is not projected to maintain the same rate of growth for FY 84 (9%). The annual growth in the DL components of the total funding vary considerably from FY 82 through FY 84.

There was an actual growth of 8.6% in the Defense Science Research line from FY 82 to FY 83 with the growth remaining essentially constant at 8% for FY 84. The significant growth of 15.5% in the LDF line from FY 82 to FY 83 is projected to contain no growth for FY 84. The combined effect of these two lines results in a growth in the 6.1 program element of 9.5% from FY 82 to FY 83 and 6.2% for FY 84. The 6.2 line between FY 82 and 83 shows a 4% increase, but a small decrease from 83 to 84. The annual increase in the 6.2 line of 6% to 7%, on the other hand, shows little change from FY 81 through FY 83. As a result, the purchasing power of this line is losing ground to inflation.

The concern expressed last year, regarding inadequate DL 6.3A funding for the transition of our technology developments, continued during FY 83. The situation improved, however, with nearly a 66% increase over 82 and forecasting a 32% increase in 84. With these increases, we are slowly closing in on the objective of a 6.2/6.3 ratio of 1:1. The growth in Product Division 6.3B type funding experienced in FY 83 is projected to accelerate in FY 84 and beyond.

DARPA funding from FY 82 - FY 85 shows a gradual decline from the FY 82 40 Million to an estimated 17 Million in 85. This is partly explained by the lack of visibility in the out year funding.

The Laboratory On-Line Network Experiment (LONEX) system is proving itself a valuable tool in management and efficiency of resources. This asset has been given considerable visibility during the past year and other AFSC organizations have expressed an interest in its capabilities.

The C3I mission continues to be given greater emphasis at the highest levels in the DOD. It seems clear that the priorities the Center places on the multitude of options to provide advanced C3I capabilities is correct. The effort to maintain a balance between innovative technology and applications is having its effect in a positive manner by maintaining a viable technology base for the future while addressing the nearer term needs. Both the needs driven and technology driven programs should continue to result in short and long term solutions to the ever changing challenges of the Strategic, Tactical, and Support C3I missions.

PROGRAM RELATIONSHIPS

Although the most significant interface is with ESD acquisition programs, a mission as broad as RADC's necessarily interrelates with that of many government agencies and industry. DOD interfaces will continue with appropriate AFSC laboratories, as well as with SD, BMO, ASD, DARPA, and the Army/Navy electronics laboratories under the direction of ESD.

Technologies directed towards the DOD and Air Force intelligence mission are in general very closely controlled at the Air Staff, AFIS, DIA and NSA. There is a close relationship between the work at RADC and that at AFWAL in the reconnaissance exploitation area. The AFWAL efforts are directed toward the sensor development while RADC primarily develops technology and systems for the exploitation and analysis of the sensor data. This cannot be effectively accomplished without continual dialogue between the two organizations.

The use of computers in the development of automation technology for the intelligence community requires a very close bond between the hardware/software developers, the users, and the applications engineers that reside in RADC. Furthermore the customer must play an integral part of the development cycle. Through the Consolidated Cryptological Program and the Tactical Cryptological Program, there is a great deal of coordination among the many SIGINT programs within the Air Force, Navy, Army and NSA. All DOD mapping and charting activities are carefully orchestrated with and generally funded by the Defense Mapping Agency. The bulk of the work in development of new techniques is the responsibility of RADC under this close guidance.

The Army and Navy have programs that are application oriented to meet their specific needs. Principal related programs include ARMY TACIES and a Joint Fusion Program. RADC maintains a continuous dialogue with these program offices.

Strategic surveillance programs in Advanced Optics are related to: AFSC's Defense Against Ballistic Missiles Initiative; Space Division's Space Defense, Space Based Space Surveillance, and Space Laser Programs; Space Technology Center's Advanced Warning System, DARPA's Advanced Sensor Demonstration, TEAL RUBY, Strategic Laser Communications and Large Optics Demonstration Experiment; and NASA's Large Structures Program.

Programs in Space Based Radar are related to: DARPA's Advanced Active Surveillance Program; Space Division's Space Based Radar Program; the Navy Integrated Tactical Surveillance System; Lincoln Laboratory's Program in Space Surveillance; and NASA's Large Structures Program.

Programs in Low Observable (Cruise Missile) Surveillance are related to the DARPA/Lincoln Laboratory Cruise Missile Detection Technology Program as well as the technology data base for EDEW, E-3A, SBR, etc., for low observable detection needs.

The principal tactical surveillance related programs include the U S Tactical Air Force's Advanced Tactical Radar (ATR), USMC L-Band Tactical Phased Array Radar (AN/TPS-59) and the USAF phased array antennas for E-3A and Advanced Airborne Interceptors. Anti-ARM technology is coordinated through a tri-service committee chaired by USDRE. Joint Anti-ARM technology efforts are being conducted in conjunction with the Army and Navy. Advanced Airborne Surveillance Radar programs are related to the E-3A program; the Navy AEW programs; the DARPA programs TEAL RAIN and HASP.

Aircraft Identification programs are related to similar work being performed by other services which is coordinated through the tri-service Non-cooperative Target Recognition (NCTR) working group and the CIS program office (ASD). Programs in Internetting are related to the USMC TAOC-85, U S Army Air Defense System program upgrades, and U S Navy R & D conducted at NRL.

In the Signal Generation and Control technology area, efforts in microwave and millimeter wave tubes and transmitters and solid state transmit/receive modules are related to complementary work at AFWAL/AAD and are coordinated with activities at other DOD and NASA Laboratories through the Advisory Group on Electron Devices on the SD Space Power Amplifier Working Group.

Communications, Command and Control technologies transcend numerous agencies and laboratories. The global common user C2 telecommunications efforts within the DOD are closely coordinated and apportioned by the DCA.

RADC has permanent representation on several DCA tri-service working groups and the RDT & E Senior Advisory Group and works closely with using organizations such as AFCC, SAC and NORAD. Similarly, efforts in tactical communications are coordinated through ESD/XR, the TRI-TAC office and appropriate offices at TAC, ESC, CENTCOM, USAFE, and PACAF. Industry technology is closely monitored and applied to military systems requirements where possible.

Efforts in fiber optic communications are particularly well coordinated, with RADC serving as the Air Force representative on the DOD Tri-Service Fiber Optics Coordinating Structure. RADC/AFWAL technology work in processors, spread spectrum and other related communications efforts are frequently reviewed for compatibility. Communications transmission programs are coordinated, where appropriate, with ESD/XR, DCA/DCEC, DCA/WSE, DCA/MSO, Space Division, TRI-TAC, USN/CSEL and USA/CORADCOM. These are the primary coordination organizations but because of the nature of the communications transmission many other organizations are involved on a secondary basis.

The Air Force Command and Control mission can only be accomplished through the extensive use of computers because of the tremendous amount of rapidly changing information that has to be considered by Commanders for use in a military environment. RADC has extensive experience in

technologies including software, decision aids, C3 Countermeasures, artificial intelligence, and distributed processing, and has been the Air Force focal point in several of these technical areas for many years.

The Division's role now is to assist in automating functions in the C2 Environment by exploiting available technology for information, storage and retrieval among many computerized C2 centers and mathematically based optimization procedures to assist in battle analysis and decision making. Inherent in automation are processes of requirements analysis, artificial intelligence system design and distributed processing. These all require extensive advancements in technology if we are to produce C2 systems that continue to meet military needs on an evolutionary basis.

The Rome Air Development Center has been the recognized leader in reliability physics since its origination and is the Air Force focal point for basic research and exploratory development in solid state device reliability.

The Solid State Device Reliability Program covers all those aspects of device design, processing, testing, reliability modelling and application which impact the assurance of quality and reliability at the device level and into the field. It relates to activities at AFWAL/AA which involve development of new solid state devices incorporating radiation hardening. It also relates to the manufacturing methods program at AFML which is directed toward the development of high-yield solid state device fabrication processes and reduced costs of newly developed devices.

The Very High Speed Integrated Circuit Program will also take advantage of the technological developments from the Solid State Device Reliability Program particularly through RADC responsibility for the development of the electrical test hardware and evaluation methodology required for the reliability assurance and qualification of the proposed high complexity, high speed signal processing microcircuits.

RADC maintains close interaction with the Army, Navy, NASA and FAA programs in solid state device reliability. The results of the Device Reliability Research Program are efficiently transferred into the RADC Exploratory Development Program, entitled, "Assurance Technology for Electronics". As Preparing Activity for the primary DOD microcircuit specifications and standards such as MIL-M-38510 "General Specifications for Microcircuits" and MIL-STD-883, "Test Methods and Procedures for Microelectronics", rapid technology transfer to the Army, Navy, NASA, FAA and industry is assured for RADC research and exploratory development results in solid state device reliability, quality/reliability assurance technology, design concepts for testability and related areas.

Membership by RADC on such groups as the Electronic Reliability Subgroup (RADC Co-Chairman) of the Joint Technical Coordinating Group-Reliability and Maintainability assures the effective extension of the solid state device application in system/equipment design.

The Electromagnetic Compatibility Intrasystem Analysis Program

(IAP), for which RADC has lead technical role, is a cooperative venture among all AFSC organizations involved in the application of electromagnetic compatibility techniques to systems acquisition, and has been used to support such programs as HAVE NOTE, SEEK TALK, SEEK IGLOO, the B-52 and the F-16 Hardness Assessment Program and the MX Program.

RADC work on electromagnetic compatibility control techniques is a direct response to the requirements for compatibility control techniques on aircraft such as the B-52, E-3, E-4, and EC-135.

The Compatibility & Measurements Branch has the lead management/technical role to determine the Electromagnetic Susceptibility/Vulnerability (EMS/V) of selected weapon systems by electromagnetic radiation (EMR) testing under Project HAVE NOTE. Electromagnetic Compatibility control techniques developed by RADC have direct applicability to these programs.

The Equipment/System Testability Program relates to the ASD Modular Automated Test Equipment Program which will expand upon initial results from the RADC program on equipment/system testability through development of optimum test equipment configurations for Air Force electronic systems.

The Reliability Prediction Program relates to the AFWAL/AA Computer-Aided Prediction of System Reliability Program including computerized thermal analysis of electronic components. As Preparing Activity for various reliability and maintainability DOD standards such as MIL-HDBK-217, "Reliability Prediction of Electronic Equipment", MIL-STD-470, "Maintainability Program Requirements", and MIL-STD-471, "Maintainability Demonstration", maximum interaction with other R/M programs throughout the Army, Navy, NASA, and FAA is assured.

Membership by RADC on such groups as the Joint Logistics Commanders Panel on Automatic Testing and the Industry Joint Automatic Test Group assures the effective implementation of the equipment/system testability methodology developed by RADC.

The Electromagnetic Sciences Division program in antennas, scattering, and propagation addresses AF needs for improved electromagnetics components and techniques for surveillance, communications, and navigation.

The in-house and contractual activities enable RADC to lead the AF effort in the creation and maintenance of the technology base for antennas and antenna systems, surface acoustic wave, magnetostatic wave and microwave and millimeter wave signal control devices, propagation studies, clutter and target reflectivity studies and applications.

Within DOD, several agencies conduct efforts pertinent to on-going AF R & D programs in electromagnetic sciences. Army and Navy programs generally relate to the special needs of land or sea-based radar and communications systems. The Defense Communication Agency (DCA) and Defense Advanced Research Projects Agency (DARPA) sponsor research and development in

specialized electromagnetic areas which are of DOD-wide interest. Such research efforts are generally performed in the service laboratories or by contract with industrial and academic organizations.

Other government agencies engaged to various degrees in related research and development include the National Oceanic and Atmospheric Administration (NOAA; propagation studies), and the Institute of Telecommunication Sciences of the National Telecommunication and Information Administration (NTIA; protocol radars).

The Division maintains a current awareness of these activities through participation in DOD sponsored activities such as the Inter-Service Antenna Group (ISAG), OUSDRE Advisory Group on Electron Devices, and through a position of leadership in professional groups including the Institute of Electronic and Electrical Engineering (IEEE) and the International Union of Radio Scientists (URSI), as well as through meetings and reviews of related programs.

The Communications Security RDT & E Program is an Air Force directed program, structured by RADC to satisfy the COMSEC requirements and priorities of the Electronic Security Command. The program also maintains a technology base effort to complement and support the National Security Agency and the service's cryptologic community requirements for secure voice, compromising emanations analysis, and secure record and data communications technology.

The Solid State Sciences Division has carefully developed its program so that it will provide the required support for C3 needs. The fiber optic communications program, is coordinated with the tri-service fiber optic committee and closely supports advanced development programs at RADC such as generic cable replacement for tactical use, etc. An intrusion resistant optical fiber communications link is under development with joint NSA funding. Technical and program consultation was provided to AFWAL/ML on MT program on long wavelength sources and detectors for fiber optics.

The optical signal processing program is also coordinated with the tri-service optical signal processing committee. An MOU was developed between AFWAL/AA and RADC/ES delineating cooperative efforts. A joint program will be in effect to develop optically addressed spatial light modulation with DARPA funding.

Sampled-analog signal processing device development supports the signal processing activities of the other RADC Divisions as well as other Air Force and DOD agencies.

The program is complementary with the AFWAL device program which emphasizes digital devices and is partially supported by AFWAL and DARPA. The program also complements CCD efforts of NRL and NOSC. Close coordination is maintained in precision Time and Frequency (T/F) research and development per DOD regulation, with the USNO, which is required to serve as a clearing house for all tri-service T/F R & D. Collaborative

work effort, and coordination are pursued with the Army and Navy through ERADCOM and NRL, their respective T/F R & D organizations.

RADC/ES pursues a vertically integrated program, as does NRL and ERADCOM from basic research through systems support. NOSC participates as the Navy's precise time and time interval (PTTI) coordinative laboratory. RADC/ES also has joint working arrangements with the T/F activities of the NBS at Boulder. Development of frequency standards responds to the needs of the System Program Offices at ESD, ASD, SD, and BMO. Substantial T/F consultation is provided by RADC/ES personnel to industrial contractors of many of the SPO's in the acquisition divisions. Consultation and support is provided to several FCRC's such as Lincoln Laboratory, MITRE, Aerospace, JPL (Cal Tech), APL (Johns Hopkins), and Sandia Labs. Joint efforts in T/F technology development are carried out with other Air Force laboratories, including AFWAL and AFML while working closely on programs of mutual interest with other divisions of RADC.

New initiatives in T/F R & D receive widespread dissemination throughout the DOD community as well as via the appropriate AGED committee review. Schottky focal plane efforts are closely coordinated with AFWAL (the center for extrinsic focal plane development), the Army Night Vision and Electro-Optics Laboratory and various Navy organizations via the AGED.

The EM materials efforts have been carefully and periodically coordinated with other DOD organizations and agencies. Frequent interchange has been accomplished through symposia and workshops across a broad spectrum and initiated in many cases by the Division (e.g., The First International Symposium on Halide and Other Non-Oxide Glasses and the NATO Workshops on The Material Aspects of InP).

The program is now totally responsive to device efforts such as optical fiber sources and detectors, optical signal processing, radiation tolerant time and frequency devices, radiation hard optical fibers, archival optical discs and so forth. Externally, it supports AFWAL and NRL engineers in radiation hard optical fibers and III-V materials, U S Army ERADCOM engineers in IR optical fibers and stable time and frequency standards, AFWAL in high transmission optical glasses, Lincoln Laboratory in the growth of special materials, and other agencies as requested.

The Radiation Effects and Hardening program is unique within the Air Force and is closely coordinated with other AF organizations via the Radiation Hardening Electronics Technology Coordinating Group (RHETCOG). The Division is a major DOD focal point in this area. A combined in-house and contractual program spans basic research through systems support. Other significant laboratories which have hardening interest are AFWL, AFWAL, RADC/RB, and AFML.

RADC/ES and RADC/RB have joint hardening-reliability efforts in support of SD needs. SPO contractors utilize our radiation facilities for characterization of their components. The division provides expert advice and fast turn around technology to ESD SPO's and other Air Force Systems Organizations. Major emphasis is presently being given to

consulting for the MIL STAR Program. The long term SPO interests for developing radiation hardened LSI/VLSI are supported by this Division's program.

Efforts of other DOD organizations are coordinated through DNA working groups and the AGED. The Division also organizes and chairs an annual meeting where system users, as well as the R & D community, coordinate and plan development efforts.

The relationship between RADC's programs and Industries IR&D work is complex. RADC annually reviews industry technical IR&D plans in support of the IR&D ceiling negotiations. In 1982 $790 million in C3I IR&D related technology was reviewed. While much of the IR&D programs are conducted for the enhancement of company expertise, those efforts which are most significant ultimately surface as unsolicited proposals or as the basis for bid responses. Thus, through this activity, industry IR&D is known within the Center. Many of these IR&D programs have resulted in significant cost effective benefits to RADC programs.

Following are examples of industry IR&D that have impacted favorably upon the Center:

The microprogrammed processor element developed under the Control Data Corporation IR&D program resulted in the basic approach to implementing the Nebula Instruction Set Architecture for the MIL-STD-1862A Brassboard.

Martin Marietta Aerospace IR&D provided DMA with alternate means of solving the problems of increased transformation algorithm processing, thus permitting competitive contracting to build a special purpose device.

HF Concept Development is a Harris Government Communications System Division IR&D project directed toward the development of bandwidth efficient, channel-adaptive modems for radio communications below 30 MHz allowing RADC to let a successful HF Modem Feasibility Study contract early in 1981 followed by an A/J modem contract late in 1981. TRW IR&D programs in software/firmware for MIL STAR compatible terminal modem processor application and in VHSIC programmable signal processor programs provide an excellent adjunct to the design verification requirements of the "Flexible Digital SATCOM Terminal Modem Program" starting in FY 83.

RCA's IR&D program in optical disk technology, initially directed toward home "video" applications, was diverted at the incentive of RADC to an extremely aggressive program for digital applications to produce the most sophisticated optical digital disk capability in the U. S.

The DANE program, a joint Motorola IR&D and RADC program, has developed a high speed vector processor for analyzing radar data in real time. IR&D of Sperry, in the area of cylindrical antenna performance and error compensation, was applied to their successful proposal for the Advanced Tactical Radar program.

Both ITT/Gilfillan and the General Dynamics IR&D program in multistatic radar technology and Texas Instrument's IR&D program in millimeter wave technology have impacted favorably upon the RADC Low Observable (Cruise Missile) Surveillance program.

Grumman Aircraft's IR&D program in RF membrane technology resulted in test articles which provided the means to generate and verify analytical techniques to predict the structural and RF performance of large furlable membranes proposed for space based radar surveillance systems. Over the past several years, ITEK has conducted IR&D in the area of deformable wavefront correctors which laid the foundation for the Monolithic Piezoelectric Mirror used as the wavefront corrector in the Compensated Imaging System.

Boeing IR&D in conformal phased arrays, microstrip antennas and wideband conformal elements has direct bearing upon the antenna technology program of RADC. Further, Boeing IR&D in E-3A related areas has helped define antenna performance required of airborne surveillance systems of the future.

Intel Corporation, through their IR&D program developed a totally new concept in microcomputers involving a computer-on-a-chip implementation of a fault tolerant, multi-processing, Ada ready architecture with large addressing capability which RADC used as a spring board for a cooperation program that would insure the radiation hardness of advanced versions of microframe computers of the IAPX-432 class.

The Electronic Devices Technology Branch of the Solid State Sciences Division transferred RADC in-house developed technology in silicide IR detector fabrication and new focal plane array design to industry where IR&D programs were then launched leading to DoD contracts from other agencies.

Industry IR&D reports have been most beneficial to the reliability, maintainability, testability, and product evaluation programs at RADC by providing information to keep abreast of advancing technology useful in evaluating proposals and establishing bidders list.

A special relationship between MITRE and RADC exists in the IR&D and Mission Oriented Investigation and Experimentation (MOIE) programs. These programs are defined through the mutual cooperation and agreement of RADC and MITRE and are therefore particularly germaine to the laboratories needs.

ROME AIR DEVELOPMENT CENTER

OCTOBER 1983

ESD (CC)*

* Lt Gen J W Stansberry (CC)
Maj Gen B D Ward (CV)

CORPORATE PLANS — Mr J W Hyde III (CCX) — AA 3705
HQ SQ SECTION — *Maj V L O'Grodnick; **MSG H M Brocksome (CCQ) — AX 2900

COMMANDER — Col C F Stebbins (CC) — AA 7701
VICE COMMANDER — Col A J Driscoll (CV) — AA 7701

CHIEF SCIENTIST — Dr F I Diamond (CA) — AAC 4512

PUBLIC AFFAIRS OFFICE — Cpt S L Hankey (PA) — EI 3053
PLANS OFFICE — Dr C P Crocetti (XP) — FX 7052
SAFETY OFFICE — Mr S M Yanik (SE) — EF 2653
SECURITY OFFICE — Cpt J E Bowman (SP) — AY 2916
INTELLIGENCE OFFICE — Lt Col J Meredith (IN) — FT 2116
STAFF JUDGE ADVOCATE — Maj F D Pulis (JA) — EJC 2087
SMALL & DISADVANTAGED BUSINESS UTILIZATION OFFICE — Mr P L Nicotera (BC) — BZ 4020
INTEGRATED LOGISTIC SUPPORT OFFICE — Lt Col C Hintze III (LW) — 7877
STAFF METEOROLOGIST — Maj K Y Nozaki (WE) — 3085

OPERATIONS OFFICE — Col R L Janzen; **Mr R W Poulliot (DO) — JO 2274
- TECHNICAL MGMT BR — **Mr R L Allen (DOT) — JOU 4323
- RESOURCES CONTROL BRANCH — Maj A E Fournier (DOR) — JOZ 3021

COMPTROLLER — Mr A Sisti (AC) — FR 3507
- BUDGET BRANCH — Mr J O'Halloran (ACB) — FRJ 3509
- ACCOUNTING BRANCH — Mr J Camerata (ACF) — FRD 3402
- R&D COMPUTER FACILITY — **Mr L Comito (ACD) — FRU 7009
- INFO RESOURCE MGMT BRANCH — Lt Col K S Nocito (ACM) — FRZ 7204

CONTRACTING DIVISION — Maj R H Shipman; Mr J Amoroso (PK) — FB 4901,4122
- CONTRACT REVIEW COMMITTEE (PKC) — FBA 2577
- PRICING OFFICE — Mr H S Rubin (PKF) — FBT 4904
- R&D CONTRACTS — Mr K P Long (PKR) — FBP 4122
- CONTRACTING SUPPORT BRANCH — Cpt P K Spendley (PKX) — FBF 3530

SUPPORT SERVICES DIVISION — Maj V L O'Grodnick; Mr J B Isom (TS) — AN 3008
- • SUPPORT SERVICES OFFICE — Maj R Elliott (TSE) — ANE 2404
- LOG MATERIEL CONTROL ACTIVITY — Mr R Borgovini (TSS) — ANJ 7772
- MAINTENANCE & TRANSPORT BRANCH — Mr J Gullo (TSN) — ANG 3247
- TECHNICAL PHOTO & ILLUSTRATION BR — Mr J Garcia (TSV) — ANP 3157
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- TECHNICAL FACILITIES OFFICE — Mr P Hackert (DE) — ANT 3131
- HISTORY OFFICE — Dr T Thompson (HO) — ANO 2757
- COMMUNICATIONS ELECTRONICS SUPPORT OFFICE — Mr R Hickok (DU) — 2243

COMMUNICATIONS DIVISION — Col J Selph; Dr B Beek (DC) — LM 4114
- COMMUNICATIONS TRANSMISSION BR — Mr L W Doubleday (DCC) — LMA 3171
- TELECOMMUNICATIONS BRANCH — Mr J D Kelly (DCL) — LMT 7667

RELIABILITY & COMPATIBILITY DIVISION — Col W S Tuthill (RB) — LQ 3064
- COMPATIBILITY & MEASUREMENTS BR — Mr S D Zaccari (RBC) — LOC 4217
- MICROELECTRONICS RELIABILITY BRANCH — Mr J B Brauer (RBR) — LQR 2945
- SYSTEMS RELIABILITY & ENGINEERING BR — Mr A J Feduccia (RBE) — LQE 4920

INTEL & RECON DIVISION — Col J P Kershaw; **Mr T J Domurat (IR) — LK 2977,2976
- INTELLIGENCE DATA HANDLING BRANCH — Mr J Gratge (IRD) — LKD 3601
- IMAGE SYSTEMS BRANCH — Lt Col L B Thompson (IRR) — LKR 4104
- SIGNAL INTELLIGENCE BRANCH — **Mr W R Sill (IRA) — LKT 7774

COMMAND & CONTROL DIVISION — Col J J Marciniak; **Mr R Raposo (CO) — LT 2165
- COMD & CONTROL SOFTWARE TECH BR — Mr S A DiNitto (COE) — LTI 7507
- BATTLE MGMT SYSTEMS TECH BRANCH — Lt Col J A Beyerle (COA) — LTD 4175
- COMD & CONTROL SYSTEMS TECH BR — **Mr R Metzger (COT) — LTF 2014

SURVEILLANCE DIVISION — Col L J Hillebrand; Mr F J Rehm (OC) — LA 7703,2302
- TACTICAL SURVEILLANCE BR — Mr J J Simons (OCD) — LAE 4119
- STRATEGIC SURVEILLANCE BR — Mr R Urtz (OCS) — LAS 4157
- SURVEILLANCE TECHNOLOGY BR — Mr F J Demma (OCT) — LAT 4016

• ELECTROMAGNETIC SCIENCES DIVISION — Dr A C Schell; Lt Col F Molinet (EE) — LE 3705,3700
- ANTENNAS & R F COMP BRANCH — Dr J K Schindler (EEA) — LEB 6865
- ELECTROMAGNETIC TECHNIQUES BR — Mr P Blacksmith (EEC) — LEC 2526
- PROPAGATION BR — MR J E Rasmussen (EEP) — LED 2900
- COMM SECURITY ENGINEERING OFFICE — Mr J P Petrano (EEV) — LES 5411

• SOLID STATE SCIENCES DIVISION — Dr H Roth; Maj J Hines (ES) — LJ 3200
- ELECT DEVICES TECHNOLOGY BR — Dr F Shepherd (ESE) — LJA 2224
- ELECTROMAGNETIC MATERIALS TECHNOLOGY BR — Mr J K Kennedy (ESM) — LJB 4034
- ELECTRO-OPTIC DEVELOPMENT TECHNOLOGY BR — Dr A C Yang (ESO) — LJC 5810
- RADIATION HARDENED ELECT TECHNOLOGY BR — Mr B L Buchanan (ESR) — LJD 4051

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AUTOVON ...

OPERATING LOCATIONS

OL AE Newport NY Mr H Russell
OL AA Ava NY Mr L Tamburrino
OL AB Moss Island Holly Cpt R Fisher
OL AK Los Angeles CA
ESD Det2 Col Springs Co Maj Kulchak
OL AD Stockbridge NY Mr H Russell
OL AH Verona NY Mr H Russell
ESD Det 15 Omaha NE Cpt Cashman
OL A[illegible] Vue Center NY Mr P Bradley

PREPARED BY RADC/DORA

RESEARCH PROGRAMS

The research program of the Rome Air Development Center is designed to provide a sound scientific basis for exploratory and advanced development programs in support of the Air Force's C3I mission. Further, the research programs are selected in order to match the Center's long range needs and to spark innovative exploratory development to provide the basis for future military systems.

Generally, the laboratory's research requirements, reflected in the AFSC Research Planning Guide, are an outgrowth of deficiencies in the laboratory's technology base. The research program which addresses these deficiencies integrates into the total laboratory program through association with the Center's Technology TPO (TPO-4) where the research program is depicted as an integral part of the technology roadmaps of TPO-4. By this technique, the identity of research supporting technology is clearly established.

The major thrusts of the research program, directed toward supporting the C3I technology base of the Center, are concentrated in electromagnetic and solid state sciences but also directly address the areas of signal processing, computer processing, device reliability, and thermionics. Specifically, the major thrusts of the research program follow:

Advanced Computer Processing Research (2304J4) - Emerging capabilities in Artificial Intelligence (AI) technology are providing new opportunities for active computer support to human information processing and decision making. Application of this technology promises to conserve effective human intellect for essential decision tasks by emphasizing the collaborative nature of AI support systems in information rich domains such as tactical command and control, software design, production and maintenance, and intelligence data analysis.

To realize the full operational potential of these experimental results, RADC has implemented a broad program of basic research and exploratory development expanding AI technology in expert systems, logic programming, advanced planning techniques, knowledge base maintenance, man-machine interfaces, and AI supporting software/hardware architectures. Demonstration AI support systems addressing the advanced information processing requirements in applications domains that include the three above are being implemented as part of the general RADC technology program. Expanded capabilities resulting from this research program in AI will further enhance these demonstration systems towards providing real-time operational information processing and decision making support.

Electronic Device and Circuit Research (2305J1) - This program explores semiconductor device phenomena, device fabrication techniques and circuit architectures with the goal of meeting future Air Force requirements for signal sensing and processing. Advances in this area

are supported through the development of both new device designs and the application of new device processing techniques. A second thrust within the program is directed towards the realization of improved time and frequency standards. Efforts in this area include the design of improved atomic clocks to meet the ever increasing precision requirements of communications and sensing equipment, as well as, the evaluation of improved quartz resonator designs with the goal of reducing the environmental sensitivity and cost of future clocks.

Radio Wave Propagation Studies and Computations (2305J2) - A major objective of the research in electromagnetic wave propagation is to develop and expand mathematical techniques to predict signal strengths of waves propagating over the surface of the earth, through the atmosphere, in the earth-ionosphere waveguide, and through the ionosphere.

Areas of interest include longwave propagation (ELF/VLF/LF/MF), and high frequency-ionospheric propagation (HF).

Particular emphasis is on the propagation of radio waves under anomalous conditions, and on the possible exploitation of non-conventional modes of propagation. Long wave research includes investigations of the relative effects of ionospheric disturbances and low altitude reflecting layers on the propagation of conventional transverse magnetic (TM) waves and heretofore unexploited transverse electric (TE) waves. These efforts use recently developed mathematical techniques which permit the determination of electron-density models of the ionosphere from long wave pulse reflection data. The non-conventional generation of long waves by the interactions of particle beams in the ionosphere is also being investigated. Waves excited by modulating high current electron beams in the ionosphere are being identified and quantified in a theoretical research program, and plans are being developed for an experiment in space to investigate the feasibility of using modulated particle beams to generate ELF/VLF radio waves.

An experimental program is planned involving the propagation of HF radio signals from a ground-based transmitter to a low-altitude orbiting satellite, using ionospherically ducted modes. These signals can propagate to great distances with relatively low losses, and offer the possibility of being exploited for surveillance and communication purposes. Research efforts are addressing a number of critical areas involving such HF ducted modes, including the time/space availability of the modes, propagation losses, duct bandwidths, and signal coherence within the ducts. Theoretical efforts are also being undertaken to determine more efficient techniques for injecting (or ejecting) HF energy into (or out of) high altitude ducts.

An experiment is being planned to investigate the effects of high-powered operational HF radio transmitters as they interact with the ionospheric plasma. Such effects include the redistribution of electron densities in the F-layer of the ionosphere, and the attendant effects on weak signals passing through such a disturbed region, and the possible self-generation of clutter, which could effect the performance of high-powered

over-the-horizon radars.

Electromagnetic Radiators (2305J3) - RADC research on electromagnetic radiators emphasizes the establishment of those basic physical and engineering principles governing antenna performance in ground-based, airborne or spaceborne environments for diverse Air Force applications.

Environmental effects on antenna performance are often of sufficient strength to impact successful attainment of operational goals, or, when anticipated, can influence the design of the antenna system. These interactions can involve remote sources of electromagnetic interference, such as atmospheric irregularities, terrain inhomogeneities, or hostile jamming signals. The interactions can also involve nearby sources of electromagnetic incompatibility, such as other antennas, conducting portions of the antenna's own support structure or vehicle, or the earth. The goal of this work is to discover those principles that permit antenna designs that are better able to cope with those environmental threats expected to be encountered in any particular application.

This goal is accomplished in this research task by concentrating on the following three subareas: antenna pattern control, low-profile antennas, and adaptive antenna systems for radar.

The antenna pattern control work focuses on arriving at the proper shape of the antenna radiation pattern, so that a particular Air Force military objective can be met. This includes radar antenna systems with rapid wide-angle scanning coverage and precise broadband null steering for enhanced anti-jam capability. It also establishes antenna analysis and design techniques of reduced cost and complexity, and provides antenna pattern synthesis capability for secure satellite-to-satellite communications links, as well as broadband ECCM performance for radar and communications systems.

The low-profile antenna work concentrates on microstrip structures. By virtue of its low silhouette printed circuit construction, the microstrip geometry contributes to very cost effective antennas for high performance aircraft and missiles, resulting in minimal aerodynamic drag, low weight and small size for given antenna gain, lower susceptibility to jamming, and wider bandwidth for frequency hopping.

The adaptive radar antenna work is directed toward null steering in the radiation patterns of large arrays, with special emphasis on main beam jammer cancellation capability. It provides cost effective adaptive techniques for very large antenna arrays and radar systems threatened by jamming from enemy self-screening and escort jammers, as well as a high angular density of stand-off jammers.

Electromagnetic Signatures (2305J4) - Airborne and ground radars have played important roles in both strategic and tactical warfare over three decades. New radar concepts are needed to deal effectively with the ever increasing complexity and sophistication of hostile threats and

to exploit recent technological advances.

The primary goal of the electromagnetic sensor research at RADC is to obtain increased fundamental knowledge of the scattering phenomena on which electromagnetic sensor systems are based so that new electromagnetic techniques can be developed to improve the sensors used in surveillance, reconnaissance, and intelligence. Recent increased use of radar absorbing materials and shaping techniques for target radar cross sections (RCS) reduction has made target detection much more difficult. Since there is little theoretical knowledge or experimental data from radar absorbing materials, a major effort is to expand both the theory and measured data base of scattering from these materials.

A second major need is adequate models of ground clutter and multipath for the signal processing design of radar systems required for the detection of low altitude, low RCS aircraft against the ground. These two needs are essential to the performance of the AASR and SBR radar systems currently being developed as well as the cruise missile surveillance program.

A third need relates to the performance of communication systems in the presence of jamming. By modelling the joint clutter and jamming effects on a tropospheric scatter link, it is possible to analyze the effectiveness of using alternative antenna beam shapes and sites to minimize jamming contributions caused by reflections from ground clutter.

Microwave Acoustics and Magnetics (2305J5) - Microwave acoustics and magnetics research is focused on deepening our fundamental understanding of acoustic and magnetic circuits to meet needs in command, control, communications, and intelligence. The research is needed for compact signal processing devices operating directly at ultra high, microwave, and millimeter wave frequencies.

A fundamental study will be made of shear-horizontal waves excited by interdigital transducer grids with the objective of obtaining temperature compensation for wide-bandwidth devices. Piezoelectric semi-conductors will be investigated to exploit the integration of acoustic and active devices. Techniques will be discovered for temperature compensating thin film resonators on GaAs. New orientations of quartz which are insensitive to thermal transient stress and are temperature compensated over a wider temperature range, will be studied with the goal of reducing the oven requirement for fast warmup clocks. Techniques will be developed for exciting temperature compensated microwave resonators with Qs that are orders of magnitude greater than quartz for compact frequency synthesizers needed in airborne doppler radar.

Above the upper frequency limit of SAW technology, new theoretical and experimental developments in magnetostatic waves will be exploited. The theoretical model of magnetostatic wave grating transducers is being expanded to include mutual coupling and magnetic material interactions for miniature, tunable microwave filters. Mode conversion will be explored to obtain electronically variable non-dispersive time delays for

wide instantaneous bandwidth phased arrays. GaAs field effect transistors will be combined with magnetostatic wave tapped delay lines for enhanced microwave beam steering and signal processing capabilities.

A new matrix model for magnetostatic structures will be developed together with new techniques for transversal filtering and electronically variable time delays.

Signal Processing (2305J8) - The objectives of the RADC research in this task area are to obtain new signal processing approaches providing the basis for continuing laboratory exploratory development programs and to achieve superior capabilities. These objectives will be applied to: accurately and efficiently recognizing speech to develop improved processors to allow Air Force pilots and operators to interface with and utilize command and control communications and intelligence equipment. To adaptively analyze interfering signals in the spatial and temporal domain to more effectively reject such signals and to improve usage of command and control communications channels. To effectively utilize multiple sensor surveillance systems to resolve radar targets; and to more effectively and efficiently recognize and categorize targets.

The speech processing research will apply new and powerful mathematical intelligence and pattern classification techniques to process unlimited vocabularies and obtain a facility with connected speech. The adaptive filtering research will apply new pole and zero filtering algorithms to improve the convergence rates over those currently being explored and will endeavor to improve the stability of such algorithms. Research will continue in spectral estimation to improve adaptive temporal filtering capabilities. To complete the adaptive filtering research, an effort would be conducted to apply the newer time series modeling techniques.

The surveillance research will benefit from endeavors to improve signal processing techniques to utilize multiple sensors to resolve radar targets, to overcome the effects of instabilities in the multiple sensor environment, and will benefit from the application of artificial intelligence and rule-based techniques for performing target detection in a high false alarm rate environment and for achievement of enhanced automatic recognition of various features found in digital imagery.

Thermionics Research (2305C2) - To meet projected Air Force system needs for electromagnetic transmissions, RADC is emphasizing the basic technology required to improve the performance of microwave and millimeter wave high power thermionic devices. Major emphasis is placed on achieving wide bandwidth, enhanced efficiency, higher powers with stable operation at millimeter wave frequencies, etc. and on techniques compatible with long life. Part of the research is conducted under the Air Force Thermionics Engineering and Research (AFTER) Program with the microwave tube industry and the University of Utah.

Other research includes development of techniques to analyze the internals of tubes on a nonperturbing basis. Both of these thrusts help maintain a strong technology base in this vital area. The results of the

research are applied to specific microwave and millimeter wave tube developments.

Advanced Electromagnetic Materials (2306J1) - Many electronic and electro-optical device activities are currently materials limited. Effective Air Force C3 capability depends on the availability of key electromagnetic materials. The objective of the advanced electromagnetic materials research program is to prepare and evaluate such materials.

The approach involves the synthesis, growth and characterization of electronic and optical materials in bulk, thin film and fiber form, and the identification and construction of structures that exhibit new or improved semiconductor, electro-optical and other exploitable phenomena. Primary emphasis is on militarily-distinctive, C3-oriented materials generally unavailable from the private sector.

The direct materials activities underway is an important aspect of and supportive to the time and frequency standards, fiber optic communications, integrated optics, optical data storage, monolithic integrated circuits and radiation hardening programs.

Optical Circuit Components Research (2306J2) - Recent advances in the field of optics show promise of having a similar dramatic effect on military technology to that resulting from the development of the integrated circuit technology.

The optical circuit component research at RADC is designed to provide the basis for electro-optical components and establish techniques for military fiber optic communications. Optical communications systems, providing jam-proof, secure, broadband capabilities, will fulfill important roles in C3 mission requirements. Single-strand, multimode optical fiber communications links will be emphasized. Advanced communications processing devices providing intrusion resistant, jam-proof, and highly secure broadband capabilities will be investigated as well as sophisticated switching and signal manipulation devices. High bandwidth operational capabilities of lasers and detectors will be developed. It is necessary to establish a research base so that optical circuits can be exploited to their full potential.

Experimental devices will be explored and evaluated in light of their application to control and communication requirements and their practicality.

Physics of the Interaction of Radiation with Matter (2306J3) - Our strategic policy of maintaining an assured nuclear retaliatory capability imposes a requirement for assessing the vulnerability of command, control and communications systems to the natural radiations encountered in satellite orbits and the severe environments generated by nuclear and laser weapons. Where vulnerability levels are unacceptable, radiation hardening measures must be applied.

The objective of this work is to insure the availability of fundamental

information required for identifying, characterizing, and modeling radiation damage mechanisms in electronic, electro-optical and optical devices, components, and systems so that accurate vulnerability assessments can be made and the desired level of hardening achieved. This knowledge is then applied to the design of devices and the evaluation of device characteristics during and after radiation. The program provides the basis for an extensive activity in developing a hardening technology and hardened electronics for a wide variety of Air Force systems.

Device Reliability Research (2306J4) - The evolution of solid state device technology in terms of complexity and speed will result in significant advances in the performance capabilities of future electronic systems. The device reliability research program seeks to develop the fundamental physical information required to assure the reliability of advanced solid state components and the resultant availability of Air Force systems.

The research studies are divided into two areas. First, programs are pursued which provide fundamental physical information on the mechanisms which cause failure of Very Large Scale Integrated Circuits and their associated materials. The current program is concentrating on electromigration in thin film conductors, silicide conductor stability, and surface adsorption/desorption mechanisms involving moisture and gaseous contaminants.

The second area involves developing analytical techniques required to assess the surface microchemical properties of submicrometer geometry devices and to determine the electrical operation of nodes located within the complex monolithic circuit structures.

Future efforts will also be directed toward evaluating the local thermal properties affecting microcircuit reliability. These physical and electrical assessment techniques are essential for understanding the limitations on reliability performance of emerging solid state device technologies. Finally, the device reliability research studies form the basis for further exploratory development programs pursued under Project 2338, "Assurance Technology for Electronics."

POINT OF CONTACT

Mr. Bernard M. Donovan
RADC/DORM
Griffiss AFB NY 13441
(315) 330-2912

TITLE OF TPO: COMMAND, CONTROL AND COMMUNICATIONS (C3)

This TPO articulates the goals and approaches that the laboratory is pursuing to make improvements in the Air Force's capabilities to perform its command and control mission.

Within this TPO there are four major areas of concern; namely, Support C3, Strategic C3, Tactical C3 and C3 Countermeasures (C3CM). The major objectives within each of the missions are to provide the technologies that will enhance the systems survivability, capacity, connectivity and availability.

SUPPORT C3 is defined to include those areas that are not specifically tactical or strategic in nature and provides the technologies that will improve the survivability, connectivity and security of the long haul common user communications. Though the preponderance of this work is in direct support of the DCS, the technologies developed are frequently applicable to the tactical and strategic missions.

In the switching and control of a node, the application of higher order languages (Ada) and advanced switch architecture are being pursued and will be demonstrated in the Experimental Integrated Switch Network facility. The use of LOS/TROPO communications is vital to the DCS and a program to improve link availability through the application of adaptive antennas, signal processing and spread spectrum modulations technologies is being conducted. In addition to link survivability, the network must be capable of withstanding both physical and electronic assault. Improvements in both hardware and software for the control of a complex network are needed. Such issues as fault isolation, integrated technical control, rapid net restoral/reconfiguration and the detection and identification of ECM are being addressed.

Space communications is becoming a much used and critical portion of the support communications mission, but it too suffers from the lack of AJ, mobility, flexibility and availability. These deficiencies are being addressed by providing the capabilities to operate in the SHF/EHF bands with new conformal beam forming antennas, rf generators, signal formats and reducing the potential for self interference at these critical frequencies. Both ground and airborne applications are being considered.

Communication security is an activity that is mandated by national policy. Programs in TEMPEST automation, intrusion resistant optical cables, vocoders and voice intelligibility will add to the Air Force capabilities to meet this mandate.

The STRATEGIC C3 goals are to develop the technologies which will lead to a survivable and enduring C3 structure capable of positive control of the strategic forces on a global basis even in the hostile environment of physical and electronic attack, disturbed propagation and SIGINT activities. The endurance of the command authority throughout a

full spectrum conflict will require the adoption of new procedural approaches as well as technologies.

The Strategic C3 experiment is to investigate the technological issues surrounding this endurance issue considering the use and loss of distributed processing/data bases and the communications. Understanding reconfiguration and reconstitution of the assets to provide command continuity is critical to the system architecture and doctrine.

In communications, all forms will be considered with VLF HF forming the fundamental basis. The development of new antennas with narrow beam steering and rapid retune capabilities along with a variety of signal processing techniques in both narrow and wide bandwidths are the keystones to future systems. The VLF antenna for ground and air locations is a major technological issue. Those technologies which permit antennas to be adaptive, wideband (1MHz) and mobile will be developed.

TACTICAL C3, unlike the other thrusts, contains all of the elements of Command, Control, Communications and Intelligence. The major technical deficiencies within today's tactical C3I systems are survivability, capacity, timeliness and mobility. It is these system characteristics that are being addressed in the RADC program for tactical C3. Four fundamental functional areas of communications, surveillance and identification, information processing (force management) and intelligence will be discussed in order.

COMMUNICATIONS: The approach to meeting the goals of the tactical communications mission is to solve some of the near term problems such as getting fiber optic cables into the field at the earliest possible time while taking a longer term look at the systems vulnerabilities to determine future needs. In the near term, for fiber optics, there is the design of standards for connectors, sources and detectors. A little further in the future is the family of transceivers, multiplexing, rf transmission and low fibers. The Flexible Intraconnect development will result in considerable improvement in intra and inter shelter communications.

For the longer term solutions, the Communications Vulnerability Assessment (CVA) effort with the associated evaluation facilities will permit communications systems analysis. From this, the design and development of distributed and adaptive networks can be effectively done. Within this overall framework is the need for specific advancements in survivable channels. Low cost data links and associated phased array antennas are key technical issues for near real time information flow and weapon control while being subjected to intensive jamming and SIGINT activity. Voice communications is an important part of the tactical mission, but it must be secure and jam proof. Digital techniques in the EHF band are being exploited to develop a low probability of intercept and highly jam resistant voice channel for air to air use.

SURVEILLANCE AND IDENTIFICATION: The number, speed and turning

capability of airbreathing vehicles within a theater continues to grow while the potential of radar cross section reductions become more real. These target characteristics along with an ever expanding and sophisticated EW threat presents a very challenging task for surveillance and ID systems. The development of a new technology ground based radar known as the Advance Tactical Radar will lead to solutions of many of the survivability, detection and tracking problems. A longer range program has been started that will solve the technical issues required for the construction of an Advanced Airborne Surveillance Radar capable of superior detection and tracking of very small, fast, low flying targets. The main features of this concept is that it will have a conformal array antenna which will provide greater AJ protection while reducing aerodynamic drag. Reduced track dropouts will in itself improve the identification function by lessening the need for re-identifying the same target. However, this is not adequate for the tactical environment. The integration of ESM data with radar data and correlation of data from multiple sensors are two approaches being considered.

All of the above technologies will result in added capabilities, but they must be netted together to gain the maximum advantage and provide for system survivability. A program is underway to address this nontrivial issue.

INFORMATION PROCESSING: The current methods of doing force management is largely a manual process and is far too slow for the dynamics of modern tactical warfare. The near term introduction of automated aids and the longer term systems design comprise the RADC program.

The three main technical areas being pursued are modeling and simulation, functional automation and the man-machine interface. Key features of this approach are that it is evolutionary, relies heavily on user participation and must possess the qualities of interoperability with the current and other evolving force management equipments and concepts. This program will lead to a capability to perform Command & Control functions in a modular and distributed manner. The solution to distributed and interacting data bases is vital to tactical and strategic activities if they are to survive in the future scenarios.

A communication structure of fiber optic and coax cables that form the backbone of the Systems Design Development Environment has been installed at RADC. This will create the environment for testing/evaluating many of the concepts of hetrogenous distributed systems that one would expect to find in the real world. These tools and concepts provide powerful approaches to tactical warfare management.

INTELLIGENCE: In modern tactical warfare, intelligence must be an integral part of the command and control structure and automated to the point that it is compatible with that structure. The approach being pursued is one of both near term and long term developments which will result in a highly automated multi-sensor system capable of meeting the force management needs in a highly dynamic war.

In the sensor area, work is ongoing to develop a spread spectrum capability. Automation of the exploitation of SIGINT and the reporting of the results is another effort contributing to the intelligence data base. The Multi-Imagery Exploitation System approach will provide a near real time capability for detection, identification and precise location of high priority tactical targets.

An approach to intelligence processing for tactical operations is embodied in the Intelligence Processing Subsystem, which will develop in an evolutionary manner modular sets of multi-source and multi-echelon processing capabilities.

The Penetration Analysis Support System is to aid in the process of penetration analysis and decisions through automation of the mostly manual process. Within the tactical theater there are many diverse sensors and support subsystems that have a wealth of capability and information. They need to be brought together in a cohesive and organized manner to produce the most effective results. The Combat Sensor Management and Correlation program is intended to do this function and make available to the force manager the best possible picture of the battlefield.

C3CM is the offensive and defensive activity taken to deny the enemy the use of his Command and Control assets while retaining our C2 capability. Through these actions, the effectiveness of enemy forces should be severely degraded. The approach to this vital mission for the near term is to apply the technologies of TDOA/DD and airborne MTI and voice recognition and synthesis.

For the future, the more advanced concepts of precision emitter location and passive sensor information processing to include sorting, classification and fingerprinting and a voice and signal deception program will be conducted. The direction for technological activities and architectural design is the purview of ESD/EC. Our activities are closely tied to theirs.

POINT OF CONTACT

Mr. Fred Haritatos
RADC/DOT
Griffiss AFB NY 13441
(315) 330-3046

TITLE OF TPO: RECCE/INTEL

The objectives of this TPO are to solve, in part, the problems associated with target location, sensor exploitation and intelligence data handling. There are two thrusts that address this objective; namely, Surveillance, and Correlation and Fusion.

The SURVEILLANCE program will provide the technology for detection, tracking, identification and weapon control against slow moving and fixed ground targets from standoff ranges under all weather conditions. The PAVE MOVER radar is a key element to meeting these capabilities and is a maturing ADM currently in flight test.

A program for the development of a Ground Attack Control Center (GACC) will provide those technologies and strategies to bring together the total system control of sensors, data processors, weapon selection and control for the air interdiction mission. Both these programs are being conducted in close coordination with the ESD acquisitions directorates.

CORRELATION and FUSION is a mixture of activities for the intelligence community which relate to the processing, correlation and handling of data. The critical issues are to improve the timeliness and accuracy of the intelligence production process. The application of automation in a variety of functions and methods can relieve the highly manpower intensive condition while making the output more accurate and timely. In the S/T Data Base efforts, specific computer programs are being prepared that address those unique requirements of the Technical Intelligence analyst. Analysis and correlation of the ever increasing amounts of SIGINT for technological content is clearly a place for automation because of the vast amounts of data and the repetitive nature of the analytical process.

New concepts and software are being developed specifically to do these tasks. A significant effort continues in the system design and software which support the DOD Indications and Warning and IDHS activities. The product of these efforts are being installed in many command headquarters throughout the world. The Common Digital Exploitation System (CODES) will be the culmination of a number of efforts to make image exploitation less manpower intensive, more timely and accurate. The last program in this thrust will provide the techniques to the Mapping and Charting community by which they can more accurately and rapidly perform the tasks of preparing target and navigational materials.

The extensive use of computers and sophisticated software for automation is the key. There are three distinct portions to this program which are photogrammetry, carto exploitation, and carto architecture.

POINT OF CONTACT

Mr. Richard Simard
RADC/DOT
Griffiss AFB NY 13441
(315) 330-3046

TITLE OF TPO: STRATEGIC SYSTEMS

The objective of this TPO is to pursue the technology related to providing viable surveillance and warning sensors in support of the Vanguard submissions of atmospheric Surveillance and Warning and of Ballistic Missile Surveillance and Warning within the Strategic Defense Vanguard mission.

Although all of the national needs are not considered here, the issues of placing radar and large optical systems in space, the detection and tracking of Cruise Missiles, Intel/Special Radars, Electro-Optical sensors for tracking objects in space, and Ducted Ionospheric Propagation technology for strategic detection are addressed.

These subjects are treated under two thrust areas of Atmospheric Surveillance and Warning, and Space Surveillance and Warning. Generally, the feasibility of a concept is proven through actual demonstration. This calls for large amounts of funding and resource commitment. The bulk of our funding in this TPO comes from the DARPA or the Space Division (SD).

ATMOSPHERIC SURVEILLANCE AND WARNING addresses the difficult technology issues of radar surveillance of atmospheric targets from a space platform, Cruise Missile Surveillance, and unique sensors for specific strategic or intelligence missions. The purpose of these efforts is to explore the basic technology needed to demonstrate capabilities in these areas.

The Space Based Radar subthrust, driven primarily by the CONUS air defense mission, provides technology for a multimission, all weather, global surveillance capability. Major technology emphasis is on large phased array space deployable antennas, monolithic transmit/receive modules, and advanced on-board signal processing.

In the area of large phased array space deployable antennas, analysis/simulation of a large aperture space-based array lens comprising hundreds of thousands of elements is a formidable problem. A first approximation of element currents from an infinite array analysis of the piecewise sections is being performed with higher approximations providing corrections to the currents on elements in the vicinity of discontinuities. This detailed simulation of the lens has been combined with simulations of other aspects of the SBR antenna (feed, scattering) into an analytical capability for the total antenna. This simulation capability is resident on RADC computers. During FY83 and 84, the focus will be on validation of previously developed total simulation. A generic SBR space-fed lens array membrane was designed and test articles have been built and tested.

Currently an effort is in progress to integrate phase-shift-only modules into the lens array to demonstrate that the concept will support SBR requirements. Exterior RF tests will be conducted during the

demonstration phase through FY83 and 84. In the area of monolithic transmit/receive modules, programs are underway in both Silicon-on-Sapphire (SOS) and Gallium Arsenide technologies to develop complete transmit/receive modules for phased radars on MMIC form.

A three stage, low noise amplifier has been fabricated on SOS which is about 40 times smaller than an equivalent hybrid amplifier and a phase shifter with close to zero switching and holding power has been achieved. Delivery of the first few complete modules is scheduled for late FY83. In the area of advanced on board signal processing (AOSP), a general purpose signal processor capable of supporting space missions of the late 1980's and the 1990's is being developed. The AOSP design is a hard-wired array of mutually synchronous processing elements called Array Computing Elements (ACE), which are interconnected through a system of high speed data busses and controlled through a two-level distributed operating system.

A 9 ACE brassboard has been developed to demonstrate the AOSP distributed architecture, operating system and software. During FY84 this technology will be transitioned to TPO 4.A.2 for the development of a full capability processor for a space-based E-O sensor.

In the Low Observable (Cruise Missile) Surveillance subthrust, high confidence warning and defense against low observable penetration is being pursued through the exploitation of the whole penetration threat scenario and observable multispectral properties to augment current capabilities.

Threat measurement provides the data base for system/sensor design analysis as well as for constructing test and evaluation programs. The multispectral approach is supported by passive/active test programs to evaluate system payoff and detailed design requirements. This activity is suppported by multistatic surveillance programs being developed under DARPA funding and coordinator activities of AFSC Low Observable Interface Management Group. These 6.2 efforts are direct inputs to the 6.3 demonstration program planned to commence in FY85 leading to Advanced Development Models for sensor products by FY87. System products and integrated surveillance/engagement technology products shall be provided in FY 88/89. The near term sensor processing option for upgrade to E-3A and the passive non-cooperative surveillance augmentation option to upgrade ground surveillance networks will be available in FY86/87.

Unique sensors for the surveillance of satellites, missiles and aircraft have been and continue to be developed and improved to meet requirements for space track, attack warning, intelligence and air defense. There are no 6.2 funds expended in this Intel/Special Radars subthrust since all of the work performed is in support of external agencies who reimburse RADC for the technical effort expended to effect technology transfer to the North Warning Program, SEEK IGLOO, BMEWS, CONUS OTH-B, the E-3A Enhancement Program and COBRA SHOE.

SPACE SURVEILLANCE AND WARNING provides methods to determine the mission

of space objects and to provide adequate warning by electro-optical concepts and by high frequency ducted ionospheric concepts.

Major areas in the Electro-Optical Surveillance subthrust are Spaceborne Optical Surveillance Technology and Space Defense Surveillance Technology for strategic surveillance applications.

Major breakthroughs have been achieved in large adaptive optics for space, ultra lightweight passive mirrors, active control of space structures and adaptive compensation for atmospheric degradation of optical signals for imaging and laser communications. Substantial progress has been achieved in the design and analysis of airborne sensors for near real-time E-O satellite tracking and targeting and in the design and development of adaptive optics for spaceborne laser weapons. The breakthroughs in atmospheric compensation and LWIR modeling have resulted in the ability to achieve real-time threat assessment and targeting.

Efforts in space optics and structures are aimed at the Advanced Warning System requirements and other far term advanced strategic surveillance system requirements where major advances have been made in both active and passive telescope optics in the areas of Adaptive Ultra Lightweight mirrors, advanced passive lightweight mirrors, sensors and actuators, however, the integration and control of these components is beyond the state-of-the-art. In order to achieve an integrated telescope for space applications, FY84 62702F funds will be used to design a complex laboratory experiment to evaluate control and integration technology options.

The enhancement of our Space Defense goals through real-time optical satellite assessment has been realized with the installation of the Compensated Imaging System in a 1.6 meter diameter telescope at the ARPA Maui Optical Station. 62702F funds have been used to develop and analyze an analytical model of an infrared airborne tracking system for satellite targeting in near real-time.

All key system components for the Minimum Prediction ASAT Targeting (MIPAT) concept have been shown to be within or near the state-of-the-art and detailed design of the system and the identification and analysis of detailed system components is currently underway. Analyses are also underway to expand the MIPAT concept to include emphasis on survivable, endurable space surveillance roles.

The Ducted Ionospheric Propagation subthrust is aimed at increasing understanding of ducted modes and their usefulness in surveillance and communications application. Recent theoretical research has indicated the possibility of achieving reliable long-range (10,000 km) HF (3-39MHz) radiowave propagation by exploiting ducted modes in the ionosphere at altitudes in the 150-250 km range. Natural as well as artificial modification of the ionosphere by means of intense radio frequency heating near the duct injection point have been investigated as a promising means of achieving coupling.

A satellite experiment is planned to place a unique, specially designed wideband HF (6-30 MHz) receiver system at altitudes within the expected ducting regions. Several ground transmitters will be used to inject radio signals into the ionospheric ducts utilizing both natural and man-made ionospheric irregularities. These ducted transmissions will be received at the satellite at distances greater than 10,000 km. Several signal parameters will be measured to establish the characteristics of the ducted modes. The satellite receiver system is completed and has successfully passed the required environmental tests and is thus fully space qualified.

POINT OF CONTACT

Mr. Robert Polce
RADC/DOT
Griffiss AFB NY 13441
(315) 330-3046

TITLE OF TPO: TECHNOLOGY

The objective of this TPO is to form the foundation for future solutions to technological problems within the Air Force C3I mission. Though the "ilities" may have direct system application, they are reported in this TPO because of the breadth of their usage. There is concerted effort on the part of management to insure that there is continual cross fertilization between these thrusts and the other TPOs and that as technologies reported here mature, they will be moved into the operationally oriented TPOs. In this way there is minimum duplication and clear direction given to the efforts.

There are seven thrusts within this TPO, representative of the technical fields of the Center mission divisions. The majority of the funds identified in this TPO are 6.2 funds used to perform studies, experiments and demonstrations to further the body of technical knowledge.

SURVEILLANCE thrust contains the Thermionic subthrust which is aimed at developing technologies for amplifiers and transmitters with improved levels of performance in signal fidelity, bandwidth, and efficiency and that are lightweight, low cost and easily manufactured to meet the requirements of next generation C3I systems.

For applications requiring very wide bandwidth and/or very high average powers, tubes will be used for at least ten years in the microwave frequency bands and fifteen years in the millimeter wave frequency bands. High Average Power Tube/Transmitter Development provides for tube and transmitter techniques capable of operating at multikilowatt average powers and peak powers between 100 KW and 3 megawatts. FY84 emphasis is on the development of 100 to 200 kilowatt peak power coupled cavity traveling wave tubes with efficiencies over 40%. Additional efforts are a L-band klystron for BMEWS and the AN/TPS-43 Radar and a High Efficiency Wideband Klystron and Transmitter Equipment for the E3A tube/transmitter development.

Underlying the thermionics area is the Air Force Thermionics Engineering Research program which is a cooperative program among the Air Force, the tube industry and the University of Utah in which new circuit concepts are researched. As an adjunct to the thermionics program, Adaptive Solid State T/R Module Circuit Technology is being developed in circuit concepts and control techniques required to apply MMIC to ground and airborne surveillance systems. Emphasis in FY84 is on efficient variable output amplifiers and MMIC module circuit concepts whose performance does not degrade with variations in the manufacturing process. Additional efforts are the Conformal Array Module and the C-Band Module developments.

A second subthrust contained in this thrust is Signal Processing with the primary objective of providing the highest probability of detection in a time varying environment containing natural and man made interference while simultaneously minimizing false alarms.

Signal processing techniques are made adaptive so that they are self optimizing in this type environment. With the recent advances in device technology and real time processing algorithms, the signal processing program is oriented heavily toward the actual reduction to practice and experimental evaluation in an actual RF environment. Polarization Algorithm/Experiments will provide an extensive evaluation of several potential discrimination algorithms and will also provide much needed experimental data on the polarization signature on a variety of target types as well as ground clutter, weather clutter, and chaff. The optimum modulation/filter will be determined from an assessment of polarimetric processing for the optimum transmit/receive response for target detection and estimation over a two channel radar system.

Performance Limitation Studies will be initiated to update the diagnostic tools for determining the figure of merit for advanced radar systems as affected by the errors and limitations of a system's operating parameters. A wide range of system factors such as synchronization, time and frequency instability, A/D conversion, dynamic range and netting are some of the more immediate issues. Recent developments in distributed processing, device technology (VHSIC) and high order languages will be used in the design of the Signal Processor for E-3A/AASR to achieve high throughput, increased reliability, reduced maintenance and life cycle costs.

The singularly successful Advanced Onboard Signal Processor (AOSP) development program will continue with a new contractual effort in FY84 to develop a 20 ACE Brassboard Processor. At that time, the AOSP program will be transitioned into this TPO and no longer reported in TPO 3A1. Joint surveillance and communications Systolic Array Applications Study will lead to the development of algorithms and architectures for radar/communications signal processing that exploit highly parallel computing such as Systolic Arrays and VLSI/VHSIC technologies suitable for implementation projected for the 1985-1990 period.

COMMUNICATIONS technology ensures effective execution of C2 functions through adequate responsive communications in the presence of current and projected C3I ECM threats by emphasizing improved performance cost, reliability and physical parameters through application of VHSIC, VLSI and advanced devices. The developed technology base will fulfill present and future AF needs in Satellite, HF, Troposopheric Scatter, data link and air-to-air communications systems.

The Adaptive Processing for Communications subthrust contains adaptive signal processing, signal processing architectures, VHSIC technology for communications, high speed digital and optical signal processing, and antenna and waveform techniques.

The exploratory development program in communications is supported by research in rapidly converging algorithms for high dynamic and large arrays, algorithms compatible with VHSIC/VLSI implementations, and optimal receiver structures for combined spatial/temporal processing.

Exploratory development emphasizes advanced communications ECCM processors and advanced communications signal processing.

In the Advanced Adaptive processors area, an adaptive array based upon a low cost LMS module is under test in the Adaptive Processing Laboratory. Extension of a narrowband cascade array processor, for operation in extreme jammer environments, to wideband jammers will continue in FY 84. An advanced adaptive processor using the MAXIMIN algorithm has been delivered and will undergo tests and evaluation. Improved adaptive algorithms are under development for large thinned spaceborne adaptive arrays for satellite communications applications.

An Adaptive Spatial Processing Laboratory consisting of an anechoic chamber with an automated antenna analyzer for automated testing, data reduction and analysis of adaptive arrays will enable the comparative evaluation of existing and new adaptive algorithms and architectures.

In the Advanced Communications Signal Processing area, high pay-off areas for VHSIC insertion for HF communication and SATCOM terminals have been completed. A high speed advanced adaptive processor will be designed and fabricated in the FY83-86 time period. The processor will exploit highly parallel computing such as Systolic Arrays and will be implemented in VLSI or VHSIC. Adaptive spatial signal processing is the main application. Channel equalization, matched filtering and spread spectrum applications will also be investigated. Optical signal processing is also being investigated for solving complex signal processing problems particularly those in which digital processing is too power consumptive. An FY84 optical insertion program will be followed by a breadboard processor in FY85 and 86. Recent advances in optical devices and optical signal processing architectures will be exploited.

Waveform distortion and wavefront distortion are being studied for their effectiveness in reducing the vulnerability of communication terminals to location, classification and potential destruction by ARMs or PGMs.

ELECTROMAGNETICS improve the performance of AF C3I systems through advances and improvements in electromagnetic technology for antennas, RF components, the electromagnetics of targets and environments, and propagation.

The Antenna subthrust, is divided into two major areas of Antenna Pattern Control and Conformal and Hemispherical Coverage.

The program in Antenna Pattern Control addresses ground and airborne radar, although HF radar and LF communications antenna studies are also included. The major support to the Advanced Tactical Radar and the Advanced Airborne Surveillance Radar programs, that forms the core of the antenna pattern control effort, includes efforts that address a wide range of technical issues pertinent to future radar systems. Continuing studies address the limits of achievable antenna pattern control in terms of sidelobes and wideband null depth, while a FY84 effort will evaluate the potential of digital beamforming systems for tactical radar.

The program in Conformal and Hemispherical Coverage Antennas has the goal of developing antenna technology for EHF SATCOM airborne terminals. The program includes monolithic receive array efforts at 20GHz and monolithic and hybrid integrated circuit efforts at 44 GHz. At 20GHz it appears that fully monolithic array technology is feasible. At 44 GHz, monolithic technology, hybrid integrated circuit technology and array architecture are planned for development to reduce the element of risk. A recently completed development of a 44 GHz array of stripline fed slots is one of the major elements in the risk reduction plan.

The RF Components subthrust furthers developments in RF, SAW and MMIC technology to provide miniature components critical to the implementation of ECCM capabilities for C3I systems. SAW and dielectric resonator oscillators are examples of the types of devices being developed. An understanding of the fundamental causes of SAW oscillator aging should lead to the long term stabilities needed in advanced communication and IFF systems.

SAW oscillators at UHF are needed as multiple use frequency standards to reduce the present cost of acquiring and maintaining a separate clock on each system. Frequency synthesizers capable of rapidly hopping over a wide range of microwave frequencies will be achieved by advances in low-loss bulk over-tone acoustic resonator technology. A rapidly tunable or agile SAW filter will provide anti-jam for ICNIA. A dielectric resonator stabilized local oscillator will be developed at EHF to eliminate the oven presently used in MM wave radios. Electronically variable time delay units are required for steering phased arrays with the wide instantaneous bandwidths required for ECCM and tactical target identification.

A continuously variable time delay unit with a volume under 1 inch is being developed using magnetostatic wave technology. A stepwise variable microwave acoustic wave delay line is being developed for both phased array beamsteering and wideband direction finding. Low loss diode switches with a power handling capacity of 1 KW will be developed to enable phased array surveillance radars to achieve ECCM with long coded waveforms.

The Electromagnetics of Targets and Environment subthrust, which is in the field of electromagnetic scattering, is divided into Electromagnetics of Targets and Electromagnetics of the Sensor Environment.

Targets are defined primarily as aircraft and missiles and the sensor environment is defined as the physical terrain in which a ground radar is located and in which a target is to be detected. The main emphasis is on scattering phenomena from shaped targets made of lossy absorbers designated as low observables, on problems of the physical environment, and on the implications of these phenomena for radar detection.

In the electromagnetics of scattering from lossly dielectric materials

area, analytic and numerical calculations plus experimental measurements are applied to the problem of the detection of low observables. A data base of monostatic and bistatic scattering properties of Cruise Missiles is urgently needed for radar system detection and tracking of such low observable missiles. An analytical effort, to develop models of scattering from rough surfaces for a variety of terrain types, to make measurements to provide calibrated clutter data for a data base to use in Cruise Missile detection, and to verify model predictions, addresses the degradation of radar performance in detecting and tracking low observable, low altitude targets due to both clutter and multipath. The characterization of physical terrain permits the calculation of multipath reflections and their effects on radar performance and allows scattering models and prediction of multipath and clutter in real time to be achieved. The work to predict the optimum site for best ULSA performance is now being applied to siting of the AN/TRC-170.

The Propagation subthrust is divided into two areas of propagation technology relating to communications and to surveillance. Efforts in communications exploit characteristics of wave propagation for new communication techniques and to improve the performance of existing systems from VLF through EHF with major emphasis on survivable propagation, HF technology and SHF/EHF communications.

The Survivable Communication Programs address the LF, HF and VHF frequency bands. LF efforts assess propagation during disturbed ionospheric conditions and include an investigation of the survivability and jamming vulnerability of LF signals radiated in the TE mode from aircraft. Previously specified high-latitude propagation parameters are being applied to propagation models for the evaluation of communication reliability and survivability. HF Survivable Communications is receiving increased emphasis with efforts addressing high-latitude survivability and wideband availability. In the VHF spectrum, the survivability and availability of meteor burst propagation is being addressed. SHF/EHF Propagation Programs are being conducted to determine the limitations imposed by the troposphere on microwave and millimeter wave C3 systems. The effects of tropospheric multipath on digital communication links to establish maximum data rates possible over long digital L-C-S links are being studied, as well as the possibility of using adaptive techniques for improved reliability. New initiatives are underway to improve troposcatter models and to investigate frequency dependency of troposcatter.

Propagation for Surveillance involves the detection of targets by means of EM radiation in the radio portion of the spectrum from VLF through microwave frequencies with emphasis in HF. Characterization of ionospheric clutter and its suppression for increased effectiveness of OTH radar systems are being pursued.

The Spatially Adaptive Propagation Program is a new initiative which will explore limitations imposed by the propagation medium on HF adaptive beam control. A program is continuing to study techniques for altering the ionospheric structure in limited areas using powerful RF transmitters for

improved communication and surveillance systems.

SOLID STATE DEVICES provide for the development of advanced devices for present and future electronic C3I systems by improving knowledge and techniques necessary to develop system timing components, signal processing devices, electro-optical devices, electromagnetic device materials, and electromagnetic radiation hardening of devices.

The Systems Timing Components subthrust addresses precision frequency standards and clocks to ensure precise time interval and accurate time keeping are available for AF systems with emphasis on quartz oscillators and atomic frequency standards.

The Quartz Oscillator Program is directed toward providing quality quartz materials, resonators and oscillators focusing on improved over all performance, by minimizing aging and temperature effects on stability, while reducing cost and increasing reliability. Atomic Frequency Standards R and D embodies development of rubidium, cesium and hydrogen maser devices. A comprehensive Time and Frequency Test Facility is operated and maintained by RADC for measurements under ambient conditions and instrumentation for simulation of operating conditions.

The Signal Processing Devices subthrust addresses the development of advanced, high performance programmable signal processing devices and silicide based infrared mosaic arrays, based upon silicon VLSI technology, for sensing and signal processing in C3I systems with particular application to advanced battlefield sensors, communication ECCM, intelligence gathering systems, and command decision aids. During FY84, a high throughput scalar product operator chip will be completed under the Sampled Analog Signal Processors Program with an image processing demonstration planned for FY85. Silicon Foundry Terminals will be delivered and put into operation during FY84 with Foundry chip development to begin in FY85. In FY84, initial demonstration of a monolithic CCD with a 244 x 160 detector mosaic is planned with array scaling to 256 x 320 in FY85.

The Electro-Optical Devices subthrust provides for the development of electro-optic devices and techniques involving fiber optics as a new approach to data transmission and optical processing to achieve higher speeds and decreased component cost and size, while achieving better reliability to adverse environments. Multimode components, long wavelength sources and detectors, planar couplers, single element wavelength multiplexers and demultiplexers, and E-O switches will provide a modular approach for high performance, low cost fiber optics military transmission systems.

Optical fibers and cables will be characterized to assure performance of general, as well as intrusion resistant fiber optic links. Optical time domain reflectometry, refractive index profiling, exhaustive measurements and analysis, and optical fiber cable connectors are additional device areas being addressed.

Optical signal processing techniques, providing fast, parallel processing capability, will be studied by investigating two approaches; namely, non-coherent processing for correlation using a new pupil plane correlator and coherent processing for code acquisition.

The Electromagnetic Device Materials subthrust involves the identification, synthesis, characterization and growth of materials for effective C3I capability. New fiber optic materials, and materials and techniques for the fabrication of laser and LED sources, detectors and other devices for operation in the 1.1-1.6 micron wavelength range are actively being studied. Hydrothermal growth of high purity, low defect quartz, not available in industry is continuing. Techniques for achieving increased capability of optical discs and storage media are also continuing. In the FY84-86 time frame, second generation indium phosphide single crystal material will be grown to optimize source and detector structures for fiber optic communications and other optical systems.

Other C3I material developments, in addition to hydrothermal quartz and other piezoelectric/pyroelectric materials, are various chemical compositions such as fluoride glasses, halide compounds and conventional silicate glasses.

The Electromagnetic Radiation Hardening subthrust supports the development of a radiation-hardened electronic technology base and provides technology assessments to AF system offices.

The program in this subthrust is centered around LSI memories and digital logic circuits. Radiation induced failure modes are identified to support the hardening program and to provide data on advanced technology to SPOs. In the LSI memory program, solid-state replacement for plated wire using MNOS and CMOS techniques is expected by mid FY84. MESFET and POSFET technologies offer great potential for hardened VLSI. Demonstration circuits hardened to satellite radiation specification levels will be fabricated and tested to show progress and prove the compatibility of hardening techniques used with standard circuit fabrication methods.

RECCE/INTEL provides technology for improved automatic, real-time techniques and equipment to record, process and analyze intelligence information by pursuing developments in wideband recording, speech processing, and intelligence analytical methodology, and C3I data base techniques.

In the Wideband Recording subthrust, high density, high data rate, cost effective Read/Write/Erase materials will be exploited for optical digital disk applications. The development of an optical disk EDM to quantify magneto-optic materials is planned for FY 85-89. The experimental model of the first "Juke Box" 10E13 bit system will be delivered to RADC in the third quarter of FY84 with a second system to be delivered to NASA. A Durable Disk Configuration for forward area applications will be started in FY84 and will serve as a catalyst for a

new FY86 6.3 initiative in tactical optical disk.

Ultra Wideband Analog and Digital Recording Techniques in magnetic and optical laser recording technologies will be pursued and perpendicular recording concepts will be exploited in FY84 leading to advanced and engineering development models for SIGINT and C3 applications. An Optical Bragg Cell Recorder will be delivered in the first quarter of FY85.

Research in Acoustic Phonetics investigating connected speech work segmentation, intra/inter speaker variability, and coarticulation effects and exploratory development in Narrowband Speech Transmission, Speaker Independent Connected Speech Recognition, Voice Data Entry, and Interference Reduction techniques for cockpit voice control constitute the technology base in the Speech Processing subthrust. Additionally, speech processing technology in the SIGINT area supporting COMINT exploitation develops on-line, real-time, multiple channel and miniaturized speech processing technology as automated aids for analysts exploiting voice traffic.

In the Intelligence Analytical Methodology subthrust developments will enrich the intelligence analysis process by integrating advance data base techniques, knowledge based expert systems, and analytical aids. In the area of artificial intelligence, S-O-A techniques such as knowledge acquisition, knowledge representation, and inference aids will be applied to a narrow intelligence domain. Analytical methodologies will address near term operational issues by exploiting trend analysis, hypothesis formulation, and forecast generation.

An FY83 effort to develop the Intelligent Analyst System assesses current advanced database and artificial intelligence technology to develop a long range concept of an intelligent analyst workstation. FY84 efforts include Modeling Aids for I&W, Space/Missile Launch Assessment Experimental Model, and Fusion Methods. Key FY84 milestones include the initial design of an experimental model for a space/missile launch assessment expert system and initial concepts for a generic expert analyst system based on fifth generation architecture.

The C3I Data Base Techniques subthrust provides technology to support data base design, data base system architectures, data base system implementation, data base interfaces, distributed data bases, data models, user impact, standardization, very large data bases, and smart data bases. Expected to be completed in FY84 are the Automatic Data Base Generation effort concentrating on data base generation and on camouflage, concealment and deception; the Active Data Base effort demonstrating the technical feasibility of an expert knowledege base as an aid to the analyst; and the Survivable C3I Data Base Concepts effort for the enhancement of survivability and effectiveness of C3I data bases.

New activity planned for FY84 include the development of Data Acquisition and Validation Techniques; Knowledge Representation for Intelligence Systems; Data Architecture Concepts for Knowledge-Based Systems; and

Design Concepts for Data Base Utilities.

RELIABILITY, MAINTAINABILITY AND COMPATIBILITY encompasses the technology base development of solid state device reliability, equipment/system reliability and maintainability, and electromagnetic compatibility to improve the operational readiness of AF electronic systems. In addition, the DOD VHSIC program support is associated with this thrust, as well as the electrical test and on chip testability technology with emphasis on test structures essential for characterizing and evaluating complex devices.

Research foundations in the Solid State Device Reliability subthrust are being established in advanced physical analysis techniques and in the fundamental mechanisms of device failure. Reliability physics technology and failure mechanism analysis which build on the research foundation, are being continued under exploratory development. Studies concentrate in reliability assessments of technologies, analysis of mechanisms, and assessment of methods required to understand and reduce the frequency of failures in submicron and VLSIC devices. Solid State Device Analysis techniques are applied to new silicon-on-insulator technology, silicon oxynitride passivation for GaAs devices, and the evaluation of custom IC test structures. Concentrated efforts are being made to eliminate moisture as a failure mechanism.

The ability to control interface chemistry will lead to packaging and passivation technology for satisfactory life-times for VLSI and ULSI devices to the late 1980s and 1990s. The quality assessment portion of the program will concentrate on new signal processing integrated circuits to insure a smooth transition through JAN military specification to systems application.

Studies in new and effective quality and reliability assurance standards and test methods applicable to military grade solid state devices will concentrate on VLSI, microwave and limited use solid state devices. Improvements in electrical assessments are being accomplished under Electrical Test Techniques, Life Test Techniques, Testability, and VLSI Tester allowing expansion into the development of integrated computer aided design/test vector generation, automatic test equipment and the basic architecture for high speed VLSI testers. Linear test techniques for A/D and D/A converters and functional tests for analog microprocessors will be developed. New technology reliability assessment covers studies of failure mechanisms of various solid state technologies.

A major new thrust is the development of Sophisticated Monitored Accelerated Reliability Testing (SMART) providing fast reliability assessment of small volume specialized components. The installation of a unique microwave functional and reliability test facility for new third generation solid state microwave devices will be completed.

The Equipment/Systems Reliability and Maintainability subthrust addresses techniques for predicting, demonstrating and improving reliability and maintainability for increased operational readiness and

low life cycle costs of AF systems.

Advancements in reliability prediction, the foundation for all reliability engineering, result in annual revisions to MIL-HDBK-217, "Reliability Prediction of Electronic Equipment". Revisions will include the addition of VLSI failure rate models as well as missile and space reliability prediction methods in FY84 and the incorporation of VHSIC failure rates, in FY85. Coordinated with these revisions will be updates to the RADC-ORACLE computer program, an automatic prediction process, consisting of electrical stress analysis routines in FY84 and thermal analysis programs in FY85.

The publication of a non-electronic reliability prediction handbook is planned in FY84. Results of the study started in FY83 to determine how hardware reliability combines with software reliability measures to predict total system reliability will be applied to demonstrating total system reliability and procedures for specifying total system reliability requirements with studies running through FY87. Studies in nonoperating impacts on reliability and dormant reliability will continue through FY85. R&M design and test techniques provides designers with practical tools for creating and verifying reliability in their products.

RADC intends the rapid transition of new test techniques, derating guidance, and improved environmental stress screening. With the establishment of the foundation for an engineering discipline of testability, and supporting engineering tools, in FY84, automated failure modes and effects analysis techniques will be developed along with artificial intelligence applications to testability.

In FY85, RADC intends to issue guidelines on designing C3I systems for maximum fault tolerance. Testability prediction and demonstration methods will be integrated into appropriate DOD standards in FY87-88. In FY84, an automated maintainability prediction technique, coupled with ORACLE, will become the beginning of a family of automated R&M tools known as "Compustandards".

The EM Compatibility subthrust addresses the technology base necessary to provide a high assurance of EMC for AF electronic equipment, subsystems and systems in addition to providing EMC support to RADC, ESD and other AF agencies. Programs are pursued in EMC analysis, prediction, and measurements and in EMC interference control with the overall philosophy of developing techniques and methodologies to assess and control EM interference within AF electronic systems.

Major emphasis over the next several years in the EMC analysis, prediction, and Measurements sub-subthrust will be the development of analytical and experimental techniques to assess the susceptibility of high-speed, high-density integrated circuits to EM noise.

A promising approach is to exploit Automatic Microcircuit Test Equipment (AMTE) technology which will be pursued by initiating, in FY84, an AMTE Requirements for EM Susceptibility Assessments effort to define the

requirements necessary to augment current AMTE functional testers to include EM susceptibility testing. This will be followed by an implementation of an enhanced AMTE to include EM susceptibility Test Methods/Instrumentation for VLSI/VHSIC.

A companion approach to assessing IC susceptibility exploits computer simulation using macromodels which accurately predict circuit performance using minimum level of complexity in terms of circuit components. This approach will be pursued by initiating, in FY84, a Circuit Simulation Macromodels effort to develop a general modeling methodology for large scale digital integrated circuits. The response of integrated circuit protective input circuitry to interference signals, other than static charge, will be evaluated in FY84 through an EMI Performance Evaluation of IC Electrostatic Discharge Protection effort in which IC susceptibility to more general EM threats will be studies. EMI Coupling Modes in Printed Wire Assemblies will be studied in FY84 to define the coupling/crosstalk mechanisms in VLSI based equipments.

In order to preclude serious EMI problems in advanced microwave integrated circuits (MIC), a FY84 effort will examine Microelectronics EM Susceptibility to assess the potential EMI impact of using MICs in subsystems. EMC System Level Analysis Techniques will be developed to examine the EMC impact of spread spectrum modulations integrated into a weapon platform environment.

In addition to EMC technology work, EMC Technical Assistance to RADC C3 Systems is provided. The EMC Interference Control-sub-subthrust addresses EMC circuit design techniques and add-on interference control reduction device technology necessary to improve collocation of advanced C-E equipment on C3 platforms. Synthesizer/Transmitter EMC Design addresses EMC circuit design methodology to improve the signal-to-noise ratio of future UHF synthesizers and transmitters.

During FY84, an experimental model UHF Electronically Tunable Filter based on a totally new design concept will be available. Also in FY84, it is planned to investigate and develop the add-on frequency hopping interference reduction device technology necessary to reduce the impact of brute force interference to collocated receivers on C3 platforms. Add-on and potential circuit design techniques, to reduce the nonlinear harmonic and intermodulation product interference resulting from planned new frequency hopping antenna couplers installed on C3 platforms, will be studied in the HF/VHF Antenna Coupler EMC Technology area.

Support is being provided to the DOD VHSIC Program in the VHSIC Technology subthrust by assuring that devices resulting from the DOD VHSIC program are reliable and can be inserted into the AF and other DOD systems with full confidence of both initial and long term predictable performance.

The technical programs to accomplish this are engineering support of the VHSIC Phase I, II and III programs; the RADC development of selected Phase III supporting technologies; development of electrical test and

testability technology for VHSIC devices; definition of qualification requirements and technology required to support VHSIC insertion; and VHSIC insertion planning and coordination support to other RADC and ESD program managers.

Specific efforts are the Phase III E-beam lithography program to be completed in early FY84; the development of design rules for VHSIC device testability and Built In Test; and a set of software tools for testability analysis capability. These improved test techniques and capabilities will provide a significant portion of the revised qualification procedures which will be developed for the very complex VHSIC devices.

COMMAND AND CONTROL TECHNOLOGY - is responsive to the data processing needs of Air Force command and control (C2). Inadequate software technology advancement is the main deterrent to realizing the full potential of automation in C2. Further, the decentralization of computer resources for survivability and increased effectiveness, trusted systems for classified information, and computer assistance in human decision making have all been hampered by inadequate software technology. To combat these problems, software, system architecture, and decision aids/artificial intelligence are being explored.

The software subthrust addresses Software Engineering, High Order Languages and Computer Security. In the Software Engineering area, improved C3I performance, quality, and reliability are achieved by addressing the C3I Software Environment, Requirements and Design, and Software and System Quality. Automated software tools and methodologies are under development in the C3I software environment area. C3I Support Environment Definition will establish system and software development tool requirements peculiar to C3I and develop tool integration strategies critical to maximizing the effectiveness of software tools in the context of the total software life cycle, while C3I Support Environment Development will establish an initial baseline of the environment.

Life Cycle Impact Analysis Techniques, taking advantage of the common data base approach to tool integration, will specify advanced life cycle software development tools for determining the impact of proposed software system modifications. Outyear efforts will continue the development of the C3I support environment by addressing Tool Set Augmentation and Integration in support of the entire life cycle; the Intelligent Software Systems Tool emphasizing the exploitation of artificial intelligence technology; the C3I Environment Management Control and Reporting System providing advanced tools for use by management; the C3I Support Environment Users Guide for an overall methodology for the use of the C3I support environment; and the C3I System Development Environment providing operational baselines of the C3I support environment to effect the transfer of advanced software development technology to the user community.

The assessment of the Software Requirements Engineering Methodology (SREM) applicability to AF C2 systems was completed in FY83 in the

requirements and design area. Software Specification Tool Development will utilize this SREM evaluation to investigate how much tools can be integrated into a C3I programming environment. In FY84, Specification Technology Guidelines will be developed for use in properly selecting specification technology for application to AF embedded computer system developments. Also, in FY84, Software Specification Tool Improvements will enhance the SREM user interface for the software acquisition environment.

In FY83, the Automated Design Technology work has enhanced Ada related aspects of the hierarchical methodology and, in FY84, modeling techniques to assist in the software requirements and design process will be developed. In FY85, results of these efforts will lead to an Ada Oriented Specification Methodology for specifying the requirements and designs of systems to be implemented in the Ada programming language.

The C3I Rapid Prototype/Simulation Investigation which began in FY83 to develop a methodology for using prototyping in the software acquisition process will lead, in FY85, to the C3I Rapid Prototype/Simulation Development as part of an Integrated AIE/C3I Environment. A System Prototyping Testbed Development will expand the scope of the initial rapid prototyping capability and in FY87, a System Prototyping Testbed Integration will implement the testbed within an integrated programming and prototyping environment.

In the software and system quality area, the Development of Software Quality Measurements has established a comprehensive definition of software quality. Additional metrics are being developed that can be used during the requirements and design phase such as the Specification and Measurement of Software Quality Attributes for incorporating metrics in specifying quality goals during planning and in assessing these goals; Demonstration and Validation of Life Cycle Software Tools to demonstrate the use of quality measurement technology; and Software and System Quality Standards for establishing minimum standards for the acceptance of AF software products. Future metric development will include Ada Program Support Environment Quality Measurement and an Ada Quality Measurement Tool to automate the collection of measurements in that environment.

A Guidebook for Software Reliability Assessment has been developed for use during software development and new techniques for obtaining reliability predictions earlier in the software development life cycle are being developed. These techniques, described in Methods for Software Reliability Prediction and Assessment, will be combined with hardware reliability estimation techniques to achieve a System Reliability Assessment.

Improved Techniques for Software Cost Estimation enhances the SWAP/SARE process model developed by ESD. These enhancements will be incorporated into Software Life Cycle Tools for Acquisition Management to help estimate and control software cost over the entire life cycle. A MIL-STD Defense System Software Development is being pursued. In FY83, the Data

and Analysis Center for Software became a DOD Information Analysis Center with technical responsibility remaining with RADC.

In the High Order Language area, the Ada Integrated Environment (AIE) is the focus for development of Ada compilers and programming support environment that will provide initial capability for Ada software development in the AF.

The AIE will initially be hosted on an IBM 4341 and with delivery of an Ada compiler scheduled for late FY84, completion of the environment is expected in mid FY85. A test and evaluation of the AIE in the development of operational software will be conducted under the C3I Ada Test and Evaluation program. The Ada compiler for the IBM 4341 will be used as a basis for the development of a MIL-STD-1750A Ada Compiler.

In FY84, functional designs for a comprehensive Ada test and verification tool will be developed for incorporating S-O-A techniques for testing Ada software. Actual development of the tool will be accomplished under the Ada Test Tool Development and Demonstration Program. A language syntax that is familiar to the user will be undertaken in the C3I Oriented HOL. An appropriate language and translator for a specific C3I system will be developed by the C3I Oriented HOL Development and Demonstration effort.

In the Computer Security area, the emphasis is on technology demonstration and on verification technology. The Trusted System Development and Demonstration task is demonstrating maturing technology in trusted system developemnt via a security interface between multi-national intelligence processing systems within the KAIS for PACAF, and a trusted multi-level information management system for MAC. Tools and procedures for the formal specification and verification of trusted hardware and software for AF multi-level security applications and requirements will be developed and documented in guidebooks.

Generic computer security research and development will emphasize the areas of secure distributed processing, secure database management and formal verification technology in support of survivable, strategic C3I technology.

A new generation of security models, methods, and formal languages will lead to the implementation of a Second Generation Formal Security Specification/Verification Methodology for C3I. In addition, several technological developments will be pursued which address secure data base management systems, secure relational database management systems, and secure distributed systems with multi-level security.

A dedicated secure System Design Development Environment (SDDE) subchannel will be implemented during FY84 to allow connection to the Intelligence System Laboratory and the network will eventually be upgraded via the addition of a multi-level secure subnet. The development of Secure Distributed Operating System Modules will allow for the realization of multi-level secure distributed C3I systems.

Finally, the AF is cooperating with the Army in the development of a Multi-level Secure Operating System for Nebula (MIL-STD-1862) computers.

The System Architecture subthrust addresses one of the prime attributes of future C3I systems; namely, dispersion of physical resources to enhance survivability, in particular, decentralization of computer resources and data. Since within a C3I system, the primary objective is to accept, process and present data to a decision maker, both system attributes as well as data dependent attributes must be considered.

The efforts within this subthrust encompass all data processing components within the C2 system as well as the linkages between components.

The Distributed System Control Structures area represents a group of efforts addressing basic issues of resource control in a distributed system and will provide basic guidelines for the design of various classes of distributed system control structures. Successful development of basic control strategies will lead to more advanced and adaptive control structures in FY84 and beyond.

A Distributed Operating System (DOS) prototype effort is providing for definition, design, implementation and evaluation of a prototype DOS and is also providing a demonstration facility. Technical issues related to Distributed System Interoperability will be addressed, in particular, the issue of communication gateways between the local area nets as well as the interoperability at the high levels of protocol. The goal is to support distributed applications spread among several nodes of internetted systems. The result should be a set of Intra-System Protocol Modules. Development of Survivable C2 System Elements must provide for a minimum level of performance, that is, graceful degradation and reconfiguration of processing resources to accommodate losses in data processing nodes and/or communication links.

The Intelligence Information Systems Concepts work seeks to adapt the distributed system technology to intelligence application to support concepts such as inferential processing, deductive reasoning and knowledge based processing. Using this analysis and System Architecture Evaluation, an Intelligence Network Architecture will be implemented and evaluated. Distributed Systems Modeling/Simulation, critical to development of distributed processing, provides Performance Models and Survivability/Reliability Models which simulate partial outage modes and communication links within the system and determines the effect on system performance. To provide a vehicle to integrate the various technologies applicable to C2, the implementation of a SDDE has been undertaken. The nucleus for the system is a C2 Facility which will be implemented during FY83-84.

As noted under the computer security sub-subthrust, a Secure Subchannel operating at the secure level will be implemented in FY84-85. Allied with this subthrust is the computer architecture technical area

consisting of the Josephson Junction technology development program, AF evaluation of MIL-STD 1862 and the investigation of advanced highly fault tolerant computer architectures for C2. The Subnanosecond Signal Processor effort is developing JJ device fabrication and production technology which will be demonstrated via a signal processor in the first quarter of FY86.

A MIL-STD 1862 brassboard will be delivered to RADC in the second quarter of FY84. This breadboard will be integrated into the RADC C2 Laboratory via the SDDE. Modular C3I Standard Computer Systems Elements Evaluation will develop C2 software for use in evaluating Nebula.

Finally, Advanced computer Architecture Technology for C2 addresses post 1990 AF requirements and matches these to the technology that can be expected to be in place in that time frame. The activity tends to look for revolutionary rather than evolutionary approaches to implement computer systems such that orders of magnitude improvements can be realized in both performance and fault tolerance. The longer term activities anticipate the AF input to the five year upgrade cycle of MIL-STD 1862, the increased use of VHSIC technology in embedded computers, and the increased use of artificial intelligence and decision aids to manage the computing resource itself.

The Decision Aids/Artificial Intelligence subthrust addresses the development of functionally flexible, responsive and user adaptable decision aids using advanced computer information processing and display technology and artificial intelligence (AI) technology to assist the C3I decision maker.

The C2 Decision Aids Development Program emphasizes tactical decision aiding, critical strategic functions, and transition of decision aid technology into operational C2. The Tactical Decision Aiding Program will develop a complement of Integrated TACS Decision Aids by improving information through a vertical thread of functions via a set of Integrated Decision Aids for Offensive Counter Air mission planning. The Integrated TACC will provide more effective horizontal information flow within a TACC.

At higher command level, Senior Battlestaff Decision Aids will assist battle commanders to assess apportionment of resources and the impact of action and counteraction of various battlefield options. A parallel development program in Strategic Targeting/Reconstitution Decision Aids will be pursued. Basic analysis and technology-problem domain matching techniques will be applied to defining, designing and complementing Strategic C2 Decision Aids.

Option Generation Aids will produce the tools and environment to aid military decision makers in formulating and evaluating options for courses of action and then selecting the best action. Means of transitioning decision aids technology to a diverse set of end computer supported C2 systems and a diverse set of users is being addressed through development of a Decision Aid Development Tools Environment,

which when integrated with standard C2 development environments allow developers to build decision aids under competitive procurement constraints; through Evaluation Techniques for Decision Aids which provides for pre-operational test and evaluation of decision aids; and through User Integrated Aids which will provide for greater user acceptability of decision aids in addition to greater ease of learning and effectiveness.

An advanced development effort, Tactical Expert Mission Planner, using knowledge based mission planning concepts, will expand the mission areas to include Defense Counter Air, Battlefield Air Interdiction, Combat Air Patrol and Close Air Support.

The AI portion of this subthrust creates an in-house capability for applied AI. The technology base program is concentrated in advanced planning, man-machine interface, knowledge maintenance, inference and problem solving, advanced architectures, expert systems engineering, and the application of AI technologies to the software life cycle problem.

Distributed Problem Solving and Planning research will support the development of the planning capability required in the distributed C2 systems of the future and Knowledge Based Mission Replanning research will continue to extend the static single mission planning prototype into a capability for multiple dynamic planning and replanning.

Natural Language Parsing Techniques are presently evaluating competing approaches to man-machine interface while the Intelligence C2 System Interface research will contribute to more flexible, mixed media human-oriented interfaces to computer systems through the use of natural languages and graphics. Logic Programming Truth Maintenance in-house research investigates the validity of data used by decision makers. Inference Techniques for Knowledge Management research allows large, highly structured knowledge-based systems to be tolerant of dynamic change in their knowledge bases. Research in computer aided deduction continues to support current LISP Programming Language and Logic Programming (LOGLISP) developments as efficient and powerful new means of computer inference. A demonstratable implementation of a fifth generation programming language combining the powers of LOGLISP feeds an advanced development program to develop a highly efficient "production quality" version of the present LOGLISP system.

AI processing techniques will investigate specialized or novel hardware for intelligent systems and advanced programming environments including the development of a selected architecture using VHSIC technology. Supporting technology needed to enable cost effective use of expert systems in AF programs will be accomplished through Expert Systems Tool Evaluation and Expert Systems Technology Investigation.

Finally, the Knowledge Based Software Assistant portion of the AI program will attempt to consolidate the achievements of the AI research in automating the software life cycle.

POINT OF CONTACT

Mr. Kevin Moore
Mr. Jerry Lipa
RADC/DOT
Griffiss AFB NY 13441
(315) 330-3046

TITLE OF TPO: SPECIAL PROJECTS

As the name implies, the projects reported in this TPO are special in nature in that logic does not permit their inclusion in the other TPOs. The projects reported are every bit as important to the Air Force as any other but are of a general test and evaluation or support nature.

SYSTEMS/EQUIPMENT EVALUATION provides for highly instrumented, unique and cost-effective facilities for systems/equipment evaluation. These facilities, which include the Electromagnetic Compatibility test annexes, provide for test and evaluation in support of the improvement of weapon system performance and for the reduction of test, evaluation and modification costs.

The HAVE NOTE subthrust is the Air Force continuation of the DOD Special Electromagnetic Interference Program and provides the Air Force with the capability to determine the electromagnetic susceptibility/vulnerability (EMS/V) of air-launched weapon systems to ensure deployment without mission failure from system degradation caused by radiated electromagnetic energy. It provides the Air Force with an improved test and evaluation (TE) capability to perform EMS/V assessments on selected weapon systems by integrating an environmental threat analysis, high power radiation measurements, and analysis of special electromagnetic interference, utilizing telemetry, instrumentation and computer simulation.

Ultimately it will provide the Air Force with improved EMR methodology, analytical tools and modeling techniques to insure that the latest lessons learned during HAVE NOTE and other appropriate EMR related TE are transitioned to weapon systems.

The C3 and Protective Systems subthrust provides for highly instrumented antenna evaluation facilities capable of providing extremely accurate cost effective fine grain data for use in the design and development of C3 and electronic warfare antenna systems.

RADC's highly instrumented antenna facilities include dynamic measurement capabilities on the Precision Antenna Measurement System (PAMS) located at the Verona test Annex and static measurement capabilities at the Newport and Stockbridge Test Facilities.

The PAMS Facility accommodates all aircraft types since dynamic antenna measurements are performed through flight testing. The F-4C, D, and E; EF-111A; A-10; F-15; and F-16 airframes are currently available at Newport for antenna evaluation programs. In addition, C3 antennas and aircraft sections are accommodated. A B-52G airframe is mounted at the Stockbridge Facility and a KC-135 airframe is also available for measurements.

The Techniques and Systems Evaluation subthrust provides for expertise for development and implementation of facilities, techniques,

instrumentation and procedures for test and evaluation through all phases of system definition, development, acquisition and deployment.

RADC possesses specific test expertise and highly instrumented off-base test facilities to support AFSC directed Center managed programs. These capabilities are integrated into matrix management of Center programs which require test and evaluation.

PHYSICAL SECURITY SYSTEMS (PSS) has the basic mission of detection, identification, and location of unauthorized or potentially hostile personnel and vehicle intrusions into controlled, secure, or protected areas.

Three subsystems visualized to accomplish this mission are a detection subsystem, an imaging subsystem and an entry control subsystem. The overall program objective is to perform technical feasibility (exploratory development) and system validation (advanced development) and provide Type B product specifications and support data for electronic equipment and system segments which are to constitute a DOD standard Physical Security System. The functional role is to provide an adjunct to man-oriented security and defense methods through surveillance and detection as well as identification and control of entry to secure areas.

The detection subsystem encompasses Defense Nuclear Agency (DNA) funded exploratory development of concepts to counter the low altitude intrustion threat with future efforts involving the development of RF sensor systems that can provide an intruder tracking capability, the development of RF sensor concepts that can locate and identify the low altitude intrustion threat, and the development of portable RF sensor concepts and system. Additionally, the detection subsystem encompasses Physical Security Systems Directorate (PSSD) funded advanced development involving technical support to the Waterways Experimental Station for a ported coaxial cable sensor test and evaluation and the development of a target assessment display that will allow accurate classification of alarms for a ported coaxial cable sensor system with future effort involving recommendations to PSSD on RF sensor advanced development work and effective transition to other agencies.

The imaging subsystem encompasses current and future effort funded by PSSD for an IRCCD Fence Sensor Test and Evaluation to improve the IRCCD Fence Sensor daytime operation without adversely affecting nighttime operation.

The entry control subsystem encompasses DNA funded exploratory development involving development of an entry control concept for future DOD implementation of an automated entry control system based on personal attributes, the definition of an evaluation technique for personal attribute devices, and development of a hardware and software design to hybrid two or more personal attribute devices into some logical operational configuration with future effort focussing on developing an entry control simulator.

Additionally, current PSSD funded effort involves building and testing hand geometry and miniaturized voice verification advanced development models.

POINT OF CONTACT

Mr. Robert Polce
Mr. Kevin Moore
RADC/DOT
Griffiss AFB NY 13441
(315) 330-3046

FACILITIES

Summary: Over the years, RADC has acquired a number of unique research and development facilities. These facilities, located on Griffiss and Hanscom Air Force Bases and throughout New York State and Massachusetts represent a significant investment and as new programs and technologies emerge, they are updated, replaced, and expanded. The major existing facilities are discussed below.

GAFB: ON-BASE

Cartographic Test Facility - This facility has been created to determine the effects and interplay of new prototype equipment introduced into the automatic cartographic process. This facility, in fact, simulated a major portion of the cartographic functions, permitting realistic test evaluation and improvement through advanced automation, equipments and techniques.

RADC Surveillance Laboratory - This facility provides a multi-domain programmable adaptive surveillance environment to evaluate experimentally radar systems and techniques as a function of frequency, polarization, waveform, bandwidth, etc. The sophisticated surveillance test complex is being instrumented with four operating radar systems covering L, S, C and X band (1200-10,000MHz) and combines the existing signal processing laboratory, the tactical target identification laboratory, the radar simulation laboratory and the video processing laboratory.

RADC High Power Laboratory - This facility, a national one-of-a-kind facility, provides for the design, fabrication and evaluation of extremely high power switching devices; pulsers and entire RF transmitters for application to radar and other technologies. A transmit/receive module evaluation facility incorporates the latest state-of-the-art for measurement of module parameters.

Digital Communications Experimental Facility (DICEF) - This is a highly flexible and unique system evaluation facility to conduct experimentation in digital communications technology. DICEF uses simulated multiple media and path conditions for real time testing of equipments and subsystems, with subsequent indepth analysis. Voice packet and message switching is integrated with DICEF transmission equipment to provide a system level experimentation capability. In addition to simulated paths, real world paths originated at off-base sites are used by connecting DICEF to the RADC Satellite Terminal, the Ava/Stockbridge HF Test Sites, Autovon Terminals, the RADC Tropo Range, and the GAFB Verona-Ava Microwave Range.

Reliability Analysis Center - This facility, used in conjunction with the Equipment/System Reliability and Maintainability program staffed by personnel under contract from the Illinois Institute of Technology Research, is the DOD focal point for the collection, analysis and dissemination of reliability experience information on solid state

devices, non-electronic parts and systems/equipment. This DOD Information Analysis Center is funded by the Defense Logistics Agency.

Solid State Device Reliability Laboratory - This complex consists of specialized facilities, each unique in their capability for reliability testing of solid state devices.

The Product Evaluation Laboratory provides for the development and application of the chemical and structural product evaluation methodology required to assess the factors affecting the quality and reliability of solid state devices.

The Failure Analysis Facility is the focus of detailed analysis of microcircuits which have failed during systems acquisition or field operation. In addition, new methods of analysis are developed to permit accurate assessment of the failure mechanisms affecting emerging device technologies.

Facilities are also available for Environmental Stress Testing and Automated Electrical Testing of a wide variety of developmental and mature technology microcircuits. Data generated in these test facilities is used to develop more effective accelerated stress reliability tests, identify device operating limits, evaluate inspection and quality assurance procedures and provide direct guidance to various military electronic system designers and users.

The Microcircuit Testability Laboratory provides RADC with the capability for simulating, testing and analyzing the electrical properties of complex devices. In addition to hardware testing equipment, software tools are used to model device architectures and thereby establish effective reliability testing procedures.

Electromagnetic Compatibility Laboratory - This facility is equipped with a complete line of RF instrumentation equipment and anechoic chambers necessary to support both the exploratory development and support activities within the Compatibility Branch. In addition, an Electromagnetic Compatibility Analysis Facility (EMCAF) provides electromagnetic radiation testing and analysis of Air Force weapon systems. The facility consists of a large anechoic chamber and two shielded rooms which house the high power RF sources and signal monitoring equipment. The EMCAF is capable of testing weapon systems up to 20 feet long over a frequency range of 50 MHz to 18 GHz. All functions including RF sources, instrumentation, and data reduction are under computer control.

GAFB: OFF-BASE

Forestport Test Annex - This facility contains the VLF Experimental Site which is a unique facility for pursuing survivable communications techniques of vital importance to MEECN.

Newport Test Annex - This facility is a truly one-of-a-kind facility

which provides for versatile and accurate measurement of free space antenna characteristics. The facility is a combination of several test ranges in a relatively quiet radio frequency (RF) environment and in an isolated area away from traveled roads and industrial complexes. RADC has full sized shells of an F-4, F-111, A-10, F-16, F-15, and B-52 sections available for mounting on 3-axis positioners with their associated antenna systems. In FY84, an upgrade program for Test Annex 1 and 2 Complexes is planned. This 2,000 sq ft addition to Bldg 1600, upgrading a short antenna measurement range, and modifying entrance roads at Newport Test Annex 1 (Tanner Hill) will provide a fully qualified test and evaluation facility at 500 MHz and below for communications countermeausres, satellite communications, communications ECCM and UHF location systems. The 6,200 sq ft addition to the present instrumentation Bldg 1625 and a 2,500 sq ft concrete hardstand in addition to commercial power and road improvements at Newport Test Annex 2 (Irish Hill) will double the AF antenna pattern test capability by providing a second test range for antenna pattern measurements of tactical aircraft F-4, F-15, F-111, F-16 and the A10 allowing RADC to meet program commitments.

Stockbridge Test Annex - This facility provides the environment for evaluation of antenna systems installed on large airframes. A full size B-52 airframe is mounted on a single axis positioner with vertical measurement capabilities being obtained by positioning vertically an elevator with receivers on a tower located 200′ away. Elevation coverage up to +90 and multiple interrogator capability for evaluation of electronically steerable and phased array antenna systems are inherent capabilities of the range.

Verona Experimental Annex - This is a highly instrumented facility which supports engineering evaluation and testing of C3 techniques, equipment and systems in the areas of ECCM, radar, communications, millimeter wave research, optical surveillance, electromagnetic vulnerability and airborne antennas. Major capabilities include search, height finder, and tracking radar systems; an advanced optical facility; a precision antenna measurement facility; and an experimental troposcatter facility, and a data reduction center.

Ava Test Annex - This facility houses a unique, high power HF transmitting facility capable of transmitting up to 300 KW (600 KW peak) through fixed Rhombic antennas, and up to 20 KW (40 KW peak) through both fixed and rotatable antennas in the 4 - 30 MHz band with a variety of radar waveforms. A companion wideband/narrowband receiver system is currently installed at the Verona Test Annex. It operates with both an in-house fabricated 12 element Beverage antenna and rotatable log periodic antenna. The Ava/Verona HF complex supports a wide variety of HF radar surveillance and communications testing as well as ionospheric propagation research and sea state monitoring experiments with the Canadian Communications Research Centre.

HAFB: ON BASE

Materials Synthesis and Development Facility - This facility contains the most up-to-date equipment, and auxiliary apparatus in the Air Force for the preparation of electromagnetic materials. These include conventional Bridgman, Czochralski, and other well-known techniques, as well as new methods being developed, such as skulling, automated Czochralski, hot forging, CVD, Hydro-Thermal, etc. These equipments, which operate over extensive temperature and pressure ranges, are sited in three special buildings designed with gas leak detectors, blow-out walls, and other safety features. This facility, located at Hanscom AFB MA is devoted to the synthesis and growth of new and/or improved electromagnetic materials for C3 applications and directly supports the device activities of the Division.

Radiation Effects Facility - This facility is a modern, fully equipped laboratory containing major irradiation sources used for the test and evaluation of electronic materials and new prototype devices. This facility consists of a collection of powerful and sophisticated instruments for irradiating materials and devices for the purpose of evaluating the effects of radiation on these devices and their ability to perform to satisfactory military standards during and after such irradiation.

The facility includes a 23 MEV linear accelerator, a 40 kilocurie gamma ray source, a flash X-ray machine, a 3 MEV Van de Graaff accelerator, a 2 MEV high current dynamitron accelerator and other miscellaneous sources. The facility is unique within the Air Force and is involved in a wide variety of studies for systems offices within the Air Force (ARBES, MX, SATIN IV, MEECN, etc.).

HAFB: OFF BASE

Ipswich Electromagnetic Measurement Facility - This facility is located approximately forty miles northeast of Hanscom AFB and consists of 65 acres and three buildings.

Its mission is threefold: first, to investigate electromagnetic techniques that promise to yield novel antennas and antenna scanning systems of potential value to Air Force communications and radar systems; second, to experimentally investigate the radar reflecting properties of model vehicles and aircraft in order to evaluate their electromagnetic signatures for identification purposes and to experimentally evaluate clutter properties; and third, to provide field test/support for evaluating new electromagnetic sensor concepts.

The site contains an excellent half-mile range for the measurement of microwave antenna patterns. A FY79 construction project improved the facility for all weather measurements and low sidelobe antenna evaluation. The facility includes an anechoic chamber with a ground screen for precise impedance and antenna coupling measurements and for investigations of radar reflectivity and signatures of scaled vehicles. The Ipswich Site is excellent for field measurements as it provides a wide range of sea and land clutter environments.

Prospect Hill Millimeter Wave Facility - This facility, a sophisticated tropospheric propagation facility, is located approximately five miles south of Hanscom AFB MA. It supports the R&D program on the limitations imposed by the troposphere on Air Force systems operating at microwave and millimeter wavelengths. The effects of the troposphere on propagation are studied so that the performance of millimeter wave earth-to-space wideband data links and terminal guidance systems can be addressed. Prospect Hill is one of the few facilities in the world with a capability to conduct accurate refractive bending, troposcatter and millimeter wave attenuation and emission measurements at elevation angles down to the horizon.

The following other existing facilities complement the major RADC facilities:

GAFB

Reconnaissance Exploitation Facility, Experimental Photogrammetric Facility, SIGINT Support Facility, Advanced Sensor Exploitation Facility, Speech Processing Laboratory, ARPA Maui Optical Station (AMOS), Integrated RF Communications Laboratory, Command and Control Guidance Test Facility, Digital Communications Switching and System Control Facility, Adaptive Array Laboratory, Satellite Communications Experimental Facility, Digital Microwave LOS Transmission Range, Experimental Tropo Scatter Range, R and D Computer Facility.

HAFB

Radiation Hardened LSI/Microprocessor Characterization Facility, Experimental Device Fabrication Facility, Electro-Optical Facility, Materials and Devices Characterization and Evaluation Facility, Frequency-Time Test Facility, Microwave Acoustics and Magnetics Fabrication Facility, Antenna Test Range, Speech Research Facility, COMSEC RDT and E Facility.

New Facilities Required:

FY83

Command and Control Simulation Laboratory - $1,100K MCP

This 5,000 sq ft facility located in Bldg 3 on Griffiss AFB will provide for various command and control positions (Centers) for experimental purposes. The facility will be electrically and physically secure and will contain a large screen display, C2 positions with video displays, and encryption equipment for external communications. Interface with facilities both on and off base is critical. This facility will support programs which demonstrate and evaluate C3I concepts, systems, subsystems, and interoperability; and provides for user/developer interactions and facilitates technology transfer.

FY84

Upgrade Newport Test Annex 1 & 2 Complexes - $2,200K MCP (See Newport Test Annex described above).

FY86

Shield Experimental Cartographic Facility and Data Base Addition - $2,050K MCP

Installation of electromagnetic shielding, filtered power system, and internal structural modifications to this existing facility will

facilitate certification for classified data processing of advanced cartographic and image processing systems. Installation of a digital data base capability will allow for a transition from hard copy to soft copy for improved processing capability.

FY87

Electromagnetic Research Facility and Radio Propagation Laboratory - $9,600K MCP

The 60,000 sq ft Electromagnetic Research facility on Katahdin Hill, adjacent to the proposed 10,000 sq ft Radio Propagation laboratory, at Hanscom AFB represents the third phase of a long term program to modernize and upgrade the Electromagnetic Sciences Division facilities. It will provide an RF component laboratory, a precision antenna measurements laboratory, and a TEMPEST laboratory. This modernized facility will allow the Electromagnetic Sciences Division to meet the R&D program challenges of the 1990's. The Radio Propagation Laboratory will permit a reorganizational consolidation of the Propagation Branch. It will provide for large scale instrumentation assembly, for outfitting small equipment shelters and antennas, and for rocket payload assembly. Propagation measurements using large microwave, HF and low frequency antennas will be accomplished using magnetic tape data processing equipment. This facility will support largely in-house programs in project 4600 and tasks in AFOSR research Project 2305, in addition to furnishing support to several programs at ESD.

FY88

C3 Surveillance/Intelligence/Reconnaissance Facility - $24,000K

The 140,000 sq ft addition to Building 3 at Griffiss AFB will provide for a new laboratory for the Surveillance Division and for the Intelligence and Reconnaissance Division.

TABLE 1

RADC Technology Planning Objectives (TPOs)

TPO 1 C3

A. Support C3

1. Communications

A. Switching and Routing
B. LOS/TROPO
C. System Control
D. Satellite Communications

2. Communication Security

B. Strategic C3

1. Enduring Strategic Communications
2. Survivable C3

C. Tactical C3

1. Communications

A. Optical Communications
B. Advanced Survivable Communication Technology
C. Modular C3
D. C3 System Design and Analysis

2. Surveillance

A. Advanced Tactical Radar (ATR)
B. Advanced Airborne Surveillance Radar
C. Surveillance Internetting/ID

3. Command and Control (C2)

A. Constant Watch
B. Ground Attack Control Center (GACC)

4. Intelligence

A. COMINT Exploitation
B. ELINT Exploitation
C. Auto Tac Intelligence
D. Combat Sensor Management and Correlation

D. C3CM

1. C3 Target Recognition

2. C3CM Battle Management and Execution

3. C3CM Deception

TPO 2 RECCE/INTEL

A. Surveillance

1. Active Target Location

B. Correlation/Fusion

1. Data Handling

A. S and T Data Base
B. Analysis and Correlation
C. DOD I and W
D. IDHS
E. Telemetry Analysis

2. Imagery Exploitation

3. Precision Guidance and Strike Products

A. Photogrammetry
B. Cartographic Exploitation
C. Carto Processing/Data Base/Architecture

4. Special Intelligence

TPO 3 STRATEGIC SYSTEMS

A. Atmospheric Surveillance and Warning

1. Space Based Radar

2. Low Observable (Cruise Missile) Surveillance

3. Intel/Special Radars

B. Space Surveillance and Warning

1. Electro-Optical Surveillance

2. Ducted Ionospheric Propagation

TPO 4 TECHNOLOGY

A. Surveillance

1. Thermionics

2. Signal Processing

B. Communications

1. Adaptive Processing for Communications

C. Electromagnetics

1. Antennas

2. RF Components

3. EM of Targets and Environment

4. Propagation

D. Solid State Devices

1. System Timing Components

2. Signal Processing Devices

3. Electro-Optical Devices

4. Electromagnetic Device Materials

5. Electromagnetic Radiation Hardening

E. RECCE/INTEL

1. Wideband Recording

2. Speech Processing

3. Intelligence Analytical Methodology

4. C3I Data Base Techniques

F. Reliability Maintainability and Compatibility

1. Solid State Device Reliability

2. Equipment/Systems Reliability and Maintainability

3. EM Compatibility

4. VHSIC Technology

G. Command and Control Technology

1. Software

2. System Architecture

3. Decision Aids/Artifical Intelligence

TPO 5 SPECIAL PROJECTS

A. Systems/Equipment Evaluation

1. HAVE NOTE

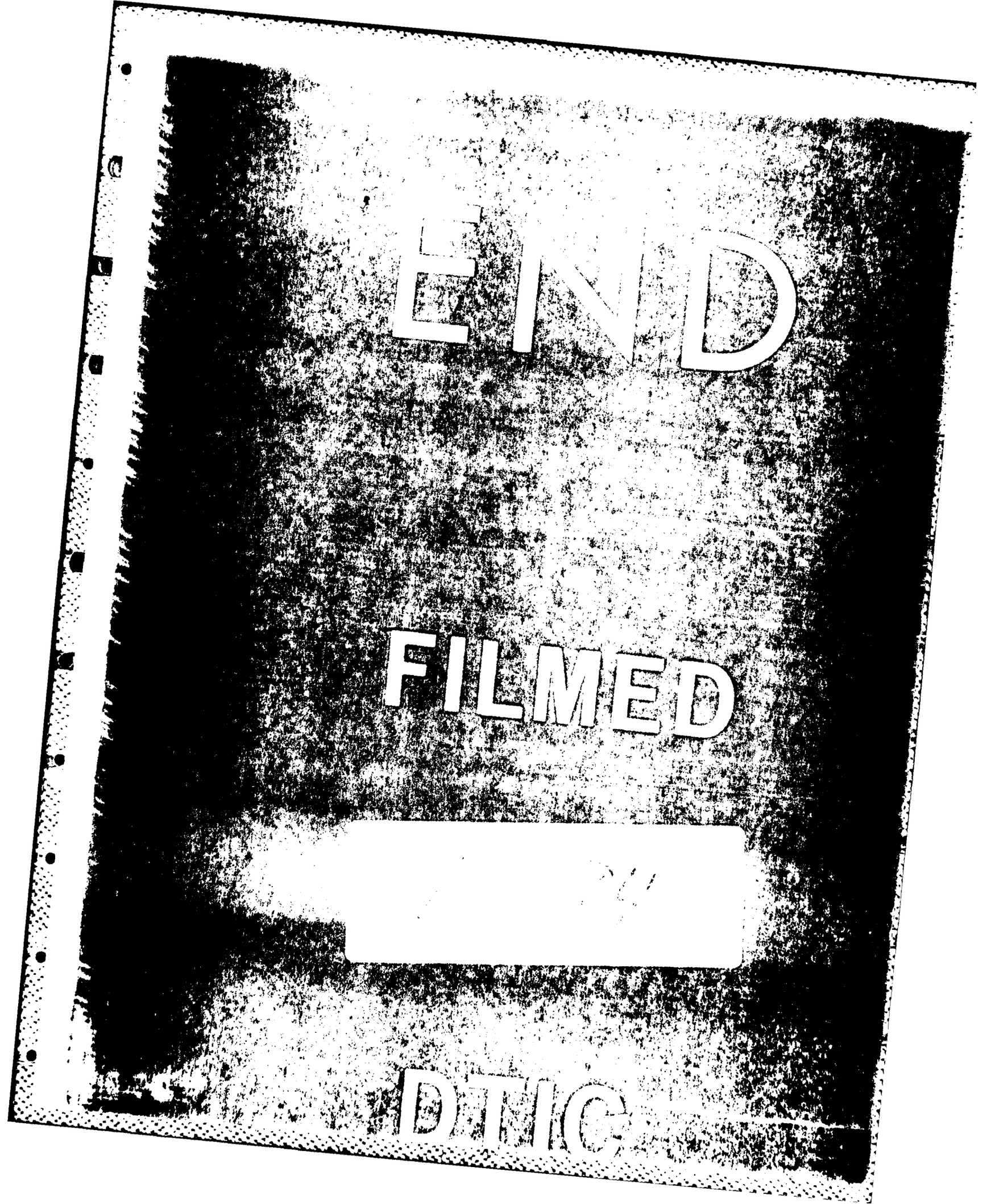
2. C3 and Protective Systems

3. Techniques and Systems Evaluation

B. Physical Security Systems (PSS)

MISSION
of
Rome Air Development Center

RADC plans and executes research, development, test and selected acquisition programs in support of Command, Control Communications and Intelligence (C^3I) activities. Technical and engineering support within areas of technical competence is provided to ESD Program Offices (POs) and other ESD elements. The principal technical mission areas are communications, electromagnetic guidance and control, surveillance of ground and aerospace objects, intelligence data collection and handling, information system technology, ionospheric propagation, solid state sciences, microwave physics and electronic reliability, maintainability and compatibility.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